



US009278981B2

(12) **United States Patent**  
**Furet et al.**

(10) **Patent No.:** **US 9,278,981 B2**  
(45) **Date of Patent:** **Mar. 8, 2016**

(54) **COMPOUNDS AND COMPOSITIONS FOR  
INHIBITING THE ACTIVITY OF ABL1, ABL2  
AND BCR-ABL1**

(71) Applicants: **Pascal Furet**, Thann (FR); **Robert  
Martin Grotzfeld**, Ettingen (CH);  
**Wolfgang Jahnke**, Lorrach (DE);  
**Darryl Brynley Jones**, Basel (CH); **Paul  
William Manley**, Arlesheim (CH);  
**Andreas Marzinzik**, Weil (DE); **Xavier  
Francois Andre Pelle**, Kembs (FR);  
**Bahaa Salem**, Basel (CH); **Joseph  
Schoepfer**, Riehen (CH); **Erich Alois  
Spieser**, Allschwil (CH)

(72) Inventors: **Pascal Furet**, Thann (FR); **Robert  
Martin Grotzfeld**, Ettingen (CH);  
**Wolfgang Jahnke**, Lorrach (DE);  
**Darryl Brynley Jones**, Basel (CH); **Paul  
William Manley**, Arlesheim (CH);  
**Andreas Marzinzik**, Weil (DE); **Xavier  
Francois Andre Pelle**, Kembs (FR);  
**Bahaa Salem**, Basel (CH); **Joseph  
Schoepfer**, Riehen (CH); **Erich Alois  
Spieser**, Allschwil (CH)

(73) Assignee: **Novartis AG**, Basel (CH)

(\*) Notice: Subject to any disclaimer, the term of this  
patent is extended or adjusted under 35  
U.S.C. 154(b) by 0 days.

(21) Appl. No.: **14/400,987**

(22) PCT Filed: **May 9, 2013**

(86) PCT No.: **PCT/IB2013/053769**

§ 371 (c)(1),

(2) Date: **Nov. 13, 2014**

(87) PCT Pub. No.: **WO2013/171640**

PCT Pub. Date: **Nov. 21, 2013**

(65) **Prior Publication Data**

US 2015/0183801 A1 Jul. 2, 2015

#### **Related U.S. Application Data**

(60) Provisional application No. 61/789,145, filed on Mar.  
15, 2013, provisional application No. 61/647,187,  
filed on May 15, 2012.

(51) **Int. Cl.**

**A61K 31/4439** (2006.01)

**C07D 498/08** (2006.01)

**C07D 401/14** (2006.01)

**C07D 405/14** (2006.01)

**C07D 413/14** (2006.01)

**C07D 401/04** (2006.01)

**C07D 401/10** (2006.01)

**C07D 403/10** (2006.01)

**C07D 413/10** (2006.01)

**C07D 471/04** (2006.01)

**C07D 487/04** (2006.01)

**C07D 487/10** (2006.01)

(Continued)

(52) **U.S. Cl.**

CPC ..... **C07D 498/08** (2013.01); **A61K 31/444**  
(2013.01); **A61K 31/4439** (2013.01); **A61K**  
**31/4545** (2013.01); **A61K 31/4725** (2013.01);  
**A61K 31/498** (2013.01); **A61K 31/506**  
(2013.01); **A61K 31/5025** (2013.01); **A61K**  
**31/551** (2013.01); **A61K 31/553** (2013.01);  
**A61K 45/06** (2013.01); **C07D 401/04**  
(2013.01); **C07D 401/10** (2013.01); **C07D**  
**401/14** (2013.01); **C07D 403/10** (2013.01);  
**C07D 405/14** (2013.01); **C07D 413/10**  
(2013.01); **C07D 413/14** (2013.01); **C07D**  
**471/04** (2013.01); **C07D 487/04** (2013.01);  
**C07D 487/10** (2013.01); **C07D 491/10**  
(2013.01); **C07D 491/107** (2013.01)

(58) **Field of Classification Search**

CPC .. **C07D 498/08**; **C07D 403/10**; **C07D 401/10**;  
**C07D 401/14**; **C07D 487/04**; **C07D 487/10**;  
**C07D 471/04**; **C07D 405/14**; **C07D 491/07**;  
**A61K 31/506**; **A61K 31/4439**; **A61K 31/444**;  
**A61K 31/4725**; **A61K 31/498**; **A61K 31/4545**;  
**A61K 31/551**; **A61K 31/553**; **A61K 45/06**;  
**A61K 31/5025**

See application file for complete search history.

(56)

#### **References Cited**

#### **U.S. PATENT DOCUMENTS**

5,017,211 A 5/1991 Wenger et al.  
7,642,272 B2 1/2010 Shankar et al.

(Continued)

#### **FOREIGN PATENT DOCUMENTS**

EP 1 746 097 A1 1/2007  
WO 89/02891 A1 4/1989

(Continued)

#### **OTHER PUBLICATIONS**

R. Angelescu et al., XVII Annals of RSCB, 246-250 (2012).\*

(Continued)

*Primary Examiner* — Alexander R Pagano

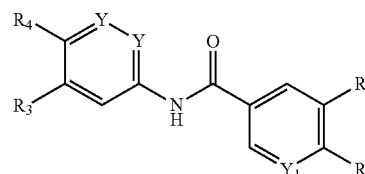
(74) *Attorney, Agent, or Firm* — Scott W. Reid

(57)

#### **ABSTRACT**

The present invention relates to compounds of formula (I): in  
which Y, Y, R, R 2, R 3 and R 4 are defined in the Summary of  
the Invention; capable of inhibiting the activity of BCR-  
ABL1 and mutants thereof. The invention further provides a  
process for the preparation of compounds of the invention,  
pharmaceutical preparations comprising such compounds  
and methods of using such compounds in the treatment of  
cancers.

(I)



**18 Claims, No Drawings**

(51)	<b>Int. Cl.</b>		WO	WO 2004054977	A1 *	7/2004	..... C07D 213/80
	<b>C07D 491/10</b>	(2006.01)	WO	2006/039718	A2	4/2006	
	<b>A61K 31/444</b>	(2006.01)	WO	2008/021725	A2	2/2008	
	<b>A61K 31/4545</b>	(2006.01)	WO	2008/051757	A1	5/2008	
	<b>A61K 31/4725</b>	(2006.01)	WO	2008/112695	A2	9/2008	
	<b>A61K 31/498</b>	(2006.01)	WO	2008/124393	A1	10/2008	
	<b>A61K 31/5025</b>	(2006.01)	WO	2008/144253	A1	11/2008	
	<b>A61K 31/506</b>	(2006.01)	WO	2009/016088	A1	2/2009	
	<b>A61K 31/551</b>	(2006.01)	WO	2009/039127	A1	3/2009	
	<b>A61K 31/553</b>	(2006.01)	WO	2009/152356	A2	12/2009	
	<b>A61K 45/06</b>	(2006.01)	WO	2011/008788	A1	1/2011	
	<b>C07D 491/107</b>	(2006.01)	WO	2011/060295	A1	5/2011	
			WO	2011/082400	A2	7/2011	
			WO	2012/129562	A2	9/2012	
			WO	2012/166951	A1	12/2012	
(56)	<b>References Cited</b>		WO	2013/171639	A1	11/2013	
	U.S. PATENT DOCUMENTS		WO	2013/171640	A1	11/2013	
	8,030,336	B2 10/2011	WO	2013/171641	A1	11/2013	
	8,829,195	B2 9/2014	WO	2013/171642	A1	11/2013	
	2003/0105143	A1 6/2003	OTHER PUBLICATIONS				
	2008/0167347	A1 7/2008	D.L. Gibbons et al., Cancer, 293-299 (2012).*				
	2010/0041657	A1 2/2010	J.S. Khorashad et al., Molecular Cancer Therapeutics, 2152 (2010).*				
	2011/0312939	A1 12/2011	A. Quintás-Cardama et al., 113 Blood, 1619-1630 (2009).*				
	2012/0149910	A1 6/2012	A. Quintás-Cardama et al., 32 Leukemia Research, 1313-1316 (2008).*				
	2013/0053370	A1 2/2013	Eck et al., The interplay of structural information and functional studies in kinase drug design: insights from BCR-Abl. Current Opinion in Cell Biology, Current Science, London, GB. Apr. 1, 2009;21(2):288-95.				
	2014/0343086	A1* 11/2014	Li et al., Design, Synthesis and Biological Evaluation of 3-(1H-1,2,3-triazol-1-yl)benzamide derivatives as Potent Pan Bcr-Abl Inhibitors Including the Threonine 315-Isoleucine 315 Mutant. Journal of Medicinal Chemistry. Nov. 26, 2012;55(22):10033-46.				
	2015/0119385	A1* 4/2015	Shin-Etsu Chemical Company Brochure for PHARMACOAT, 2005.				
	2015/0126485	A1* 5/2015					
	2015/0141427	A1* 5/2015					
	FOREIGN PATENT DOCUMENTS						
WO	01/55115	A1 8/2001					
WO	03/055477	A1 7/2003					
WO	2004/005281	A1 1/2004					

\* cited by examiner

1

# COMPOUNDS AND COMPOSITIONS FOR INHIBITING THE ACTIVITY OF ABL1, ABL2 AND BCR-ABL1

## CROSS-REFERENCED TO RELATED APPLICATIONS

This application is a U.S. National Phase filing of International Application No. PCT/IB2013/053769 filed 9 May 2013, which claims priority to U.S. Application No. 61/789,145 filed 15 Mar. 2013 and U.S. Application No. 61/647,187 filed 15 May 2012, the contents of which are incorporated herein by reference in their entirety.

## FIELD OF THE INVENTION

The present invention relates to compounds capable of inhibiting the tyrosine kinase enzymatic activity of the Abelson protein (ABL1), the Abelson-related protein (ABL2) and related chimeric proteins, in particular BCR-ABL1. The invention further provides a process for the preparation of compounds of the invention, pharmaceutical preparations comprising such compounds and methods of using such compounds in the treatment of cancers.

## BACKGROUND OF THE INVENTION

The tyrosine kinase activity of the ABL1 protein is normally tightly regulated, with the N-terminal cap region of the SH3 domain playing an important role. One regulatory mechanism involves the N-terminal cap glycine-2 residue being myristoylated and then interacting with a myristate binding site within the SH1 catalytic domain. A hallmark of chronic myeloid leukemia (CML) is the Philadelphia chromosome (Ph), formed by the t(9,22) reciprocal chromosome translocation in a haematopoietic stem cell. This chromosome carries the BCR-ABL1 oncogene which encodes the chimeric BCR-ABL1 protein, that lacks the N-terminal cap and has a constitutively active tyrosine kinase domain.

Although drugs that inhibit the tyrosine kinase activity of BCR-ABL1 via an ATP-competitive mechanism, such as Gleevec®/Glivec® (imatinib), Tasigna® (nilotinib) and Sprycel® (dasatinib), are effective in the treatment of CML, some patients relapse due to the emergence of drug-resistant clones, in which mutations in the SH1 domain compromise inhibitor binding. Although Tasigna® and Sprycel® maintain efficacy towards many Gleevec-resistant mutant forms of BCR-ABL1, the mutation in which the threonine-315 residue is replaced by an isoleucine (T315I) remains insensitive to all three drugs and can result in CML patients developing resistance to therapy. Therefore, inhibiting BCR-ABL1 mutations, such as T315I, remains an unmet medical need. In addition to CML, BCR-ABL1 fusion proteins are causative in a percentage of acute lymphocytic leukemias, and drugs targeting ABL kinase activity also have utility in this indication.

Agents targeting the myristoyl binding site (so-called allosteric inhibitors) have potential for the treatment of BCR-ABL1 disorders (J. Zhang, F. J. Adrian, W. Jahnke, S. W. Cowan-Jacob, A. G. Li, R. E. Jacob, T. Sim, J. Powers, C. Dierks, F. Sun, G.-R. Guo, Q. Ding, B. Okram, Y. Choi, A. Wojciechowski, X. Deng, G. Liu, G. Fendrich, A. Strauss, N. Vajpai, S. Grzesiek, T. Tuntland, Y. Liu, B. Bursulaya, M.

2

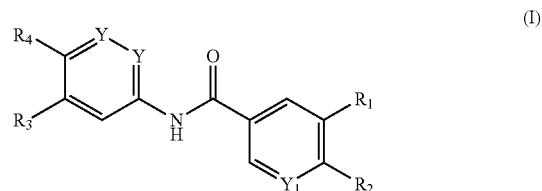
Azam, P. W. Manley, J. R. Engen, G. Q. Daley, M. Warmuth., N. S. Gray. Targeting Bcr-Abl by combining allosteric with ATP-binding-site inhibitors. *Nature* 2010; 463:501-6). To prevent the emergence of drug resistance from ATP inhibitor and/or allosteric inhibitor use, a combination treatment using both types of inhibitor can be developed for the treatment of BCR-ABL1 related disorders. In particular, the need exists for small molecules, or combinations thereof, that inhibit the activity of BCR-ABL1 and BCR-ABL1 mutations via the ATP binding site, the myristoyl binding site or a combination of both sites.

Further, compounds of the invention as inhibitors of ABL1 kinase activity have the potential to be used as therapies for the treatment of metastatic invasive carcinomas and viral infections such as pox and Ebola viruses.

The compounds from the present invention also have the potential to treat or prevent diseases or disorders associated with abnormally activated kinase activity of wild-type Abl, including non-malignant diseases or disorders, such as CNS diseases in particular neurodegenerative diseases (for example Alzheimer's, Parkinson's diseases), motoneuron diseases (amyotrophic lateral sclerosis), muscular dystrophies, autoimmune and inflammatory diseases (diabetes and pulmonary fibrosis), viral infections, prion diseases.

## SUMMARY OF THE INVENTION

In one aspect, the present invention provides compounds of formula (I):



in which:

Y at each occurrence is independently selected from N and CH;

R<sub>1</sub> is selected from pyrimidinyl, pyridinyl, phenyl, quinoxalyl and isoquinolinyl; wherein said pyrimidinyl, pyridinyl, phenyl, quinoxalyl and isoquinolinyl of R<sub>1</sub> is unsubstituted or substituted with 1 to 3 R<sub>6</sub> groups;

R<sub>2</sub> is selected from pyrrolidinyl, piperidinyl, azetidiny, morpholino, piperazinyl, 2-oxa-6-azaspiro[3.4]-octanyl, 3-azabicyclo[3.1.0]hexan-3-yl, pyrrolo[3,4-c]pyrazol-5(1H, 4H, 6H)-yl, hexahydropyrrolo[3,4-c]pyrrolyl, 6-oxo-2,7-diazaspiro[4.4]-nonanyl, 1H-pyrrolo[3,4-c]pyridinyl, 1,4-oxazepan-4-yl, 2-oxooxazolidinyl, 1,4-diazepanyl, tetrahydro-2H-pyranyl, 3,6-dihydro-2H-pyranyl, 3,8-dioxo-10-azabicyclo[4.3.1]decanyl and —NR<sub>5a</sub>R<sub>5b</sub>; wherein said pyrrolidinyl, piperidinyl, azetidiny, morpholino, piperazinyl, 1,4-oxazepan-4-yl, pyrrolo[3,4-c]pyrazol-5(1H, 4H, 6H)-yl, 2-oxa-6-azaspiro[3.4]-octanyl, 3-azabicyclo[3.1.0]hexan-3-yl, hexahydropyrrolo[3,4-c]pyrrolyl, 6-oxo-2,7-diazaspiro[4.4]-nonanyl, 1H-pyrrolo[3,4-c]pyridinyl, 2-oxooxazolidinyl, 1,4-diazepanyl, tetrahydro-2H-pyranyl,

## 3

3,6-dihydro-2H-pyran-4-yl, or 3,8-dioxo-10-azabicyclo[4.3.1]decanyl is unsubstituted or substituted with 1 to 3 R<sub>7</sub> groups;

R<sub>3</sub> is selected from hydrogen and halo;

R<sub>4</sub> is selected from —SF<sub>5</sub> and —Y<sub>2</sub>—CF<sub>2</sub>—Y<sub>3</sub>;

R<sub>5a</sub> is selected from hydrogen and methyl;

R<sub>5b</sub> is selected from C<sub>1-4</sub>alkyl and tetrahydro-2H-pyran-4-yl; wherein said alkyl of R<sub>5b</sub> is unsubstituted or substituted with 1 to 3 groups independently selected from hydroxy and dimethyl-amino;

R<sub>6</sub> at each occurrence is independently selected from methyl, methoxy, cyano, trifluoromethyl, hydroxy-methyl, methoxy-carbonyl, 2-hydroxypropan-2-yl, halo, amino, fluoro-ethyl, ethyl and cyclopropyl;

R<sub>7</sub> at each occurrence is independently selected from hydroxy, methyl, methoxy, hydroxy-methyl, amino, methyl-amino, amino-methyl, trifluoromethyl, 2-hydroxypropan-2-yl, methyl-carbonyl-amino, dimethyl-amino, cyano and amino-carbonyl; or two R<sub>7</sub> groups combine with the atom to which they are attached to form a ring selected from cyclopropyl, pyrrolo[3,4-c]pyrazol-5(1H,4H,6H)-yl and 3-azabicyclo[3.1.0]hexan-3-yl; wherein said 3-azabicyclo[3.1.0]hexan-3-yl can be optionally substituted with amino;

Y<sub>1</sub> is selected from N and CR<sub>5</sub>; wherein R<sub>5</sub> is selected from hydrogen, methoxy and imidazolyl; wherein said imidazolyl is unsubstituted or substituted with methyl;

Y<sub>2</sub> is selected from CF<sub>2</sub>, O and S(O)<sub>0-2</sub>; and

Y<sub>3</sub> is selected from hydrogen, halo, methyl, difluoromethyl and trifluoromethyl.

In a second aspect, the present invention provides a pharmaceutical composition which contains a compound of formula (I) or a N-oxide derivative, individual isomers and mixture of isomers thereof; or a pharmaceutically acceptable salt thereof, in admixture with one or more suitable excipients.

In a third aspect, the present invention provides a method of treating a disease in an animal in which modulation of BCR-ABL1 activity can prevent, inhibit or ameliorate the pathology and/or symptomology of the diseases, which method comprises administering to the animal a therapeutically effective amount of a compound of formula (I) or a N-oxide derivative, individual isomers and mixture of isomers thereof, or a pharmaceutically acceptable salt thereof.

In a fourth aspect, the present invention provides the use of a compound of formula (I) in the manufacture of a medicament for treating a disease in an animal in which BCR-ABL1 activity contributes to the pathology and/or symptomology of the disease.

In a fifth aspect, the present invention provides a process for preparing compounds of formula (I) and the N-oxide derivatives, prodrug derivatives, protected derivatives, individual isomers and mixture of isomers thereof, and the pharmaceutically acceptable salts thereof.

## DEFINITIONS

The general terms used hereinbefore and hereinafter preferably have within the context of this disclosure the following

## 4

meanings, unless otherwise indicated, where more general terms wherever used may, independently of each other, be replaced by more specific definitions or remain, thus defining more detailed embodiments of the invention:

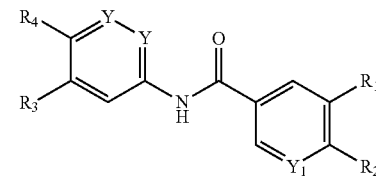
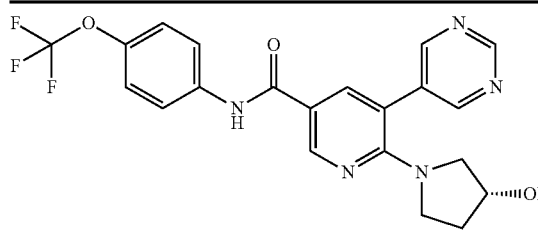
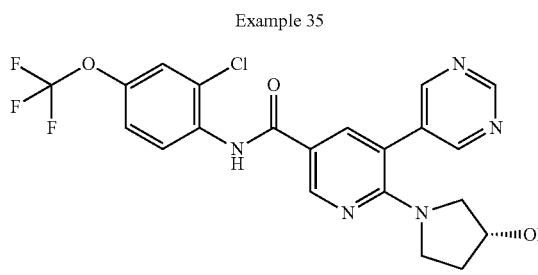
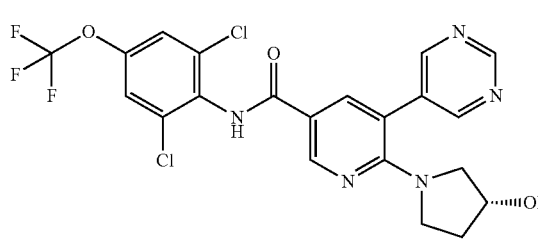
“Alkyl” refers to a fully saturated branched or unbranched hydrocarbon moiety having up to 20 carbon atoms. Unless otherwise provided, alkyl refers to hydrocarbon moieties having 1 to 7 carbon atoms (C<sub>1-7</sub>alkyl), or 1 to 4 carbon atoms (C<sub>1-4</sub>alkyl). Representative examples of alkyl include, but are not limited to, methyl, ethyl, n-propyl, iso-propyl, n-butyl, sec-butyl, iso-butyl, tert-butyl, n-pentyl, isopentyl, neopentyl, n-hexyl, 3-methylhexyl, 2,2-dimethylpentyl, 2,3-dimethylpentyl, n-heptyl, n-octyl, n-nonyl, n-decyl and the like. A substituted alkyl is an alkyl group containing one or more, such as one, two or three substituents selected from halogen, hydroxy or alkoxy groups. Halo-substituted-alkyl and halo-substituted-alkoxy, can be either straight-chained or branched and includes, methoxy, ethoxy, difluoromethyl, trifluoromethyl, pentafluoroethyl, difluoromethoxy, trifluoromethoxy, and the like.

“Aryl” means a monocyclic or fused bicyclic aromatic ring assembly containing six to ten ring carbon atoms. For example, aryl may be phenyl or naphthyl, preferably phenyl. “Arylene” means a divalent radical derived from an aryl group.

“BCR-ABL1” refers to a fusion protein created from the N-terminal exons of the breakpoint cluster region (BCR) gene and the major C-terminal part (exons 2-11) of the Abelson (ABL1) gene. The most common fusion transcripts encode for a 210-kDa protein (p210 BCR-ABL1), although rarer transcripts encode a 190-kDa protein (p190 BCR-ABL1) and a 230-kDa protein (p230 BCR-ABL1). The ABL1 sequences of these proteins contains an ABL1 tyrosine kinase domain which is tightly regulated in the wild-type protein, but constitutively activated in the BCR-ABL1 fusion proteins. This deregulated tyrosine kinase interacts with multiple cellular signalling pathways leading to transformation and deregulated proliferation of the cells.

“BCR-ABL1 mutants” refers to the numerous single site mutations in BCR-ABL1 including: Glu255→Lysine, Glu255→Valine, Thr315→Isoleucine, Met244→Val, Phe317→Leu, Leu248→Val, Met343→Thr, Gly250→Ala, Met351→Thr, Gly250→Glu, Glu355→Gly, Gln252→His, Phe358→Ala, Gln252→Arg, Phe359→Val, Tyr253→His, Val379→Ile, Tyr253→Phe, Phe382→Leu, Glu255→Lys, Leu387→Met, Glu255→Val, His396→Pro, Phe311→Ile, His396→Arg, Phe311→Leu, Ser417→Tyr, Thr315→Ile, Glu459→Lys and Phe486→Ser.

Compounds of the invention are sensitive to substitution on the R<sub>3</sub>/R<sub>4</sub> substituted ring at the position that is ortho to the point of attachment of the NHC(O) group. Compare, for example, the following compounds of formula (I). The IC<sub>50</sub> of Example 35 is <3 nM compared to a chloro or dichloro substitution with an IC<sub>50</sub> of 850 nM and >10 μM, respectively:

	
(I) Compounds of formula (I)	Caliper ABL1 (64-515) IC <sub>50</sub> [μM]
	0.0012
<p>Example 35</p> 	0.85
	>10

“Heteroaryl” is as defined for aryl above where one or more of the ring members is a heteroatom. For example C<sub>5-10</sub>heteroaryl is a minimum of 5 members as indicated by the carbon atoms but that these carbon atoms can be replaced by a heteroatom. Consequently, C<sub>5-10</sub> heteroaryl includes pyridyl, indolyl, indazolyl, quinoxalyl, quinolyl, benzofuranyl, benzopyranyl, benzothiopyranyl, benzo[1,3]dioxole, imidazolyl, benzo-imidazolyl, pyrimidinyl, furanyl, oxazolyl, isoxazolyl, triazolyl, tetrazolyl, pyrazolyl, thienyl, etc.

“Cycloalkyl” means a saturated or partially unsaturated, monocyclic, fused bicyclic or bridged polycyclic ring assembly containing the number of ring atoms indicated. For example, C<sub>3-10</sub>cycloalkyl includes cyclopropyl, cyclobutyl, cyclopentyl, cyclohexyl, etc.

“Heterocycloalkyl” means cycloalkyl, as defined in this application, provided that one or more of the ring carbons indicated, are replaced by a moiety selected from —O—, —N=, —NR—, —C(O)—, —S—, —S(O)— or —S(O)<sub>2</sub>—, wherein R is hydrogen, C<sub>1-4</sub>alkyl or a nitrogen protecting group. For example, C<sub>3-8</sub>heterocycloalkyl as used in this application to describe compounds of the invention includes morpholino, pyrrolidinyl, pyrrolidinyl-2-one, piperazinyl,

piperidinyl, piperidinylone, 1,4-dioxo-8-aza-spiro[4.5]dec-8-yl, thiomorpholino, sulfanomorpholino, sulfonomorpholino, etc.

“Halogen” (or halo) preferably represents chloro or fluoro, but may also be bromo or iodo.

Compounds of formula (I) may have different isomeric forms. For example, any asymmetric carbon atom may be present in the (R)-, (S)- or (R,S)-configuration, preferably in the (R)- or (S)-configuration. Substituents at a double bond or especially a ring may be present in cis(=Z-) or trans(=E-) form. The compounds may thus be present as mixtures of isomers or preferably as pure isomers, preferably as pure diastereomers or pure enantiomers.

Where the plural form (e.g. compounds, salts) is used, this includes the singular (e.g. a single compound, a single salt). “A compound” does not exclude that (e.g. in a pharmaceutical formulation) more than one compound of the formula (I) (or a salt thereof) is present, the “a” merely representing the indefinite article. “A” can thus preferably be read as “one or more”, less preferably alternatively as “one”.

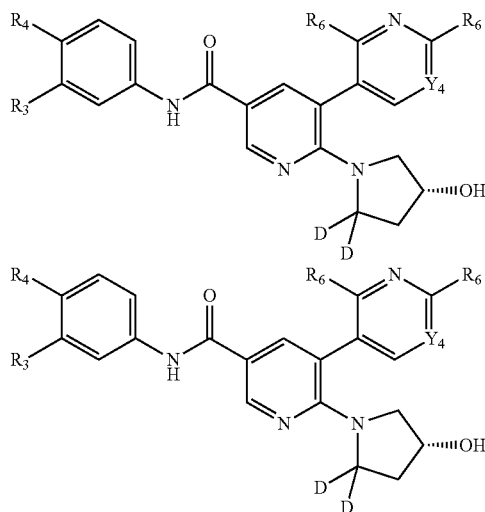
Wherever a compound or compounds of the formula (I) are mentioned, this is further also intended to include N-oxides of such compounds and/or tautomers thereof.

7

The term “and/or an N-oxide thereof, a tautomer thereof and/or a (preferably pharmaceutically acceptable) salt thereof” especially means that a compound of the formula (I) may be present as such or in mixture with its N-oxide, as tautomer (e.g. due to keto-enol, lactam-lactim, amide-imidic acid or enamine-imine tautomerism) or in (e.g. equivalency reaction caused) mixture with its tautomer, or as a salt of the compound of the formula (I) and/or any of these forms or mixtures of two or more of such forms.

The present invention also includes all suitable isotopic variations of the compounds of the invention, or pharmaceutically acceptable salts thereof. An isotopic variation of a compound of the invention or a pharmaceutically acceptable salt thereof is defined as one in which at least one atom is replaced by an atom having the same atomic number but an atomic mass different from the atomic mass usually found in nature. Examples of isotopes that may be incorporated into the compounds of the invention and pharmaceutically acceptable salts thereof include, but are not limited to, isotopes of hydrogen, carbon, nitrogen and oxygen such as  $^2\text{H}$  (D or deuterium),  $^3\text{H}$ ,  $^{11}\text{C}$ ,  $^{13}\text{C}$ ,  $^{14}\text{C}$ ,  $^{15}\text{N}$ ,  $^{17}\text{O}$ ,  $^{18}\text{O}$ ,  $^{35}\text{S}$ ,  $^{18}\text{F}$ ,  $^{36}\text{Cl}$  and  $^{123}\text{I}$ . Certain isotopic variations of the compounds of the invention and pharmaceutically acceptable salts thereof, for example, those in which a radioactive isotope such as  $^3\text{H}$  or  $^{14}\text{C}$  is incorporated, are useful in drug and/or substrate tissue distribution studies. In particular examples,  $^3\text{H}$  and  $^{14}\text{C}$  isotopes may be used for their ease of preparation and detectability. In other examples, substitution with isotopes such as  $^2\text{H}$  may afford certain therapeutic advantages resulting from greater metabolic stability, such as increased in vivo half-life or reduced dosage requirements. Isotopic variations of the compounds of the invention or pharmaceutically acceptable salts thereof can generally be prepared by conventional procedures using appropriate isotopic variations of suitable reagents.

For example, a compound of the invention can incorporate deuterium on the pyrrolidiny ring as shown:



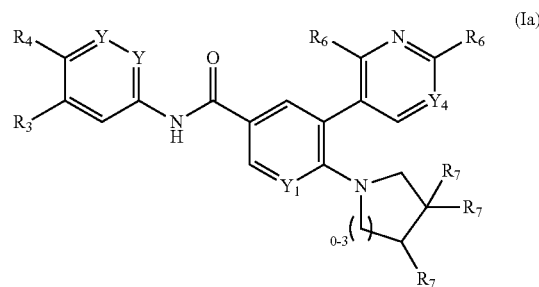
This deuterated form is less prone to metabolic transformation (left, above) compared with the non-deuterated form (right, above).

8

## DESCRIPTION OF PREFERRED EMBODIMENTS

The present invention relates to compounds capable of inhibiting the activity of BCR-ABL1 or mutants of BCR-ABL1 through the allosteric, myristoyl binding site.

In one embodiment, with respect to compounds of the invention, are compounds of formula (Ia):



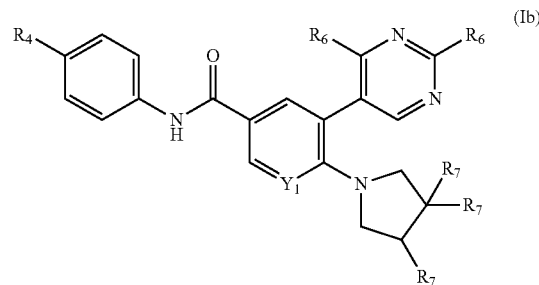
in which:

Y is selected from N and CH;

R<sub>3</sub> is selected from hydrogen and halo;

R<sub>4</sub> is selected from —SF<sub>5</sub> and —Y<sub>2</sub>—CF<sub>2</sub>—Y<sub>3</sub>; R<sub>6</sub> at each occurrence is independently selected from hydrogen, methyl, methoxy, cyano, trifluoromethyl, hydroxy-methyl, halo, amino, methoxy-carbonyl, 2-hydroxypropan-2-yl, fluoro-ethyl, ethyl and cyclopropyl; R<sub>7</sub> at each occurrence is independently selected from hydroxy, methyl, methoxy, hydroxy-methyl, amino, methyl-amino, amino-methyl, trifluoromethyl, 2-hydroxypropan-2-yl, methyl-carbonyl-amino, dimethyl-amino, cyano and amino-carbonyl; or two R<sub>7</sub> groups combine with the atom to which they are attached to form a ring selected from cyclopropyl, pyrrolo[3,4-c]pyrazol-5(1H,4H,6H)-yl and 3-azabicyclo[3.1.0]hexan-3-yl; wherein said 3-azabicyclo[3.1.0]hexan-3-yl can be optionally substituted with amino; Y<sub>1</sub> is selected from N and CR<sub>5</sub>; wherein R<sub>5</sub> is selected from hydrogen, methoxy and imidazolyl; wherein said imidazolyl is unsubstituted or substituted with methyl; Y<sub>2</sub> is selected from CF<sub>2</sub>, O and S(O)<sub>0-2</sub>; and Y<sub>3</sub> is selected from hydrogen, halo, methyl, difluoromethyl and trifluoromethyl; Y<sub>4</sub> is selected from CR<sub>6</sub> and N; or the pharmaceutically acceptable salts thereof.

In another embodiment are compounds of formula (Ib):

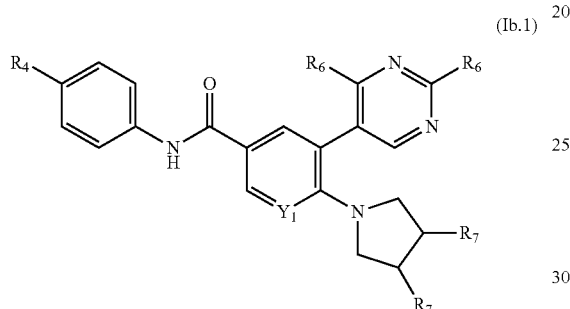


in which: R<sub>4</sub> is selected from —SF<sub>5</sub> and —Y<sub>2</sub>—CF<sub>2</sub>—Y<sub>3</sub>; R<sub>6</sub> at each occurrence is independently selected from hydrogen, methyl, methoxy, cyano, trifluoromethyl, hydroxy-me-

9

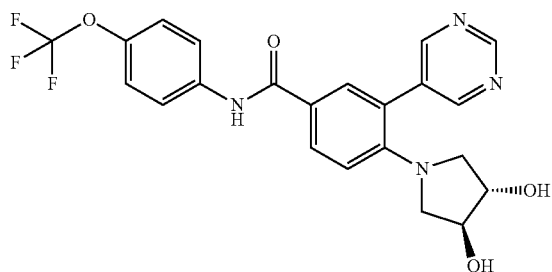
thyl, halo, amino, methoxy-carbonyl, 2-hydroxypropan-2-yl, fluoro-ethyl, ethyl and cyclopropyl;  $R_7$  at each occurrence is independently selected from hydroxy, methyl, methoxy, hydroxy-methyl, amino, methyl-amino, amino-methyl, trifluoromethyl, 2-hydroxypropan-2-yl, methyl-carbonyl-amino, dimethyl-amino, cyano and amino-carbonyl; or two  $R_7$  groups combine with the atom to which they are attached to form a ring selected from cyclopropyl, pyrrolo[3,4-c]pyrazol-5(1H,4H,6H)-yl and 3-azabicyclo[3.1.0]hexan-3-yl; wherein said 3-azabicyclo[3.1.0]hexan-3-yl can be optionally substituted with amino;  $Y_1$  is selected from CH and N;  $Y_2$  is selected from  $CF_2$ , O and  $S(O)_{0-2}$ ;  $Y_3$  is selected from hydrogen, fluoro, chloro, methyl, difluoromethyl and trifluoromethyl; or the pharmaceutically acceptable salts thereof.

In a further embodiment are compounds of formula (Ib.1):



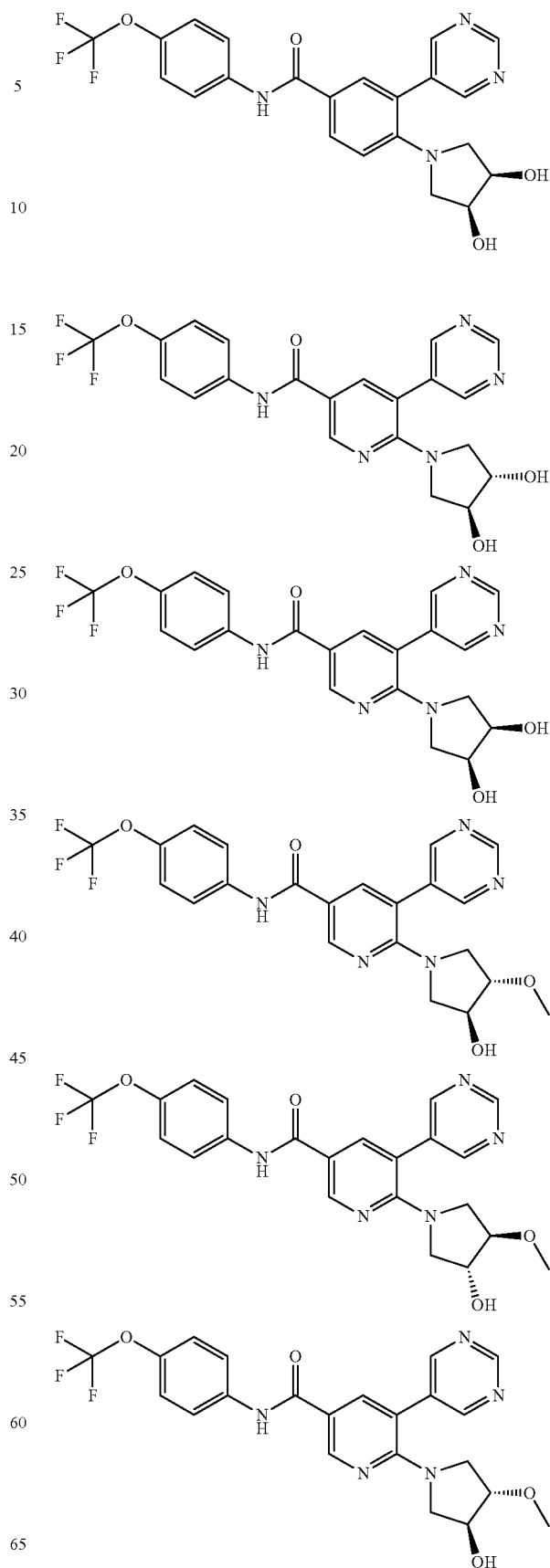
in which:  $R_4$  is selected from  $-SF_5$  and  $-Y_2-CF_2-Y_3$ ;  $R_6$  at each occurrence is independently selected from hydrogen, methyl, methoxy, cyano, trifluoromethyl, hydroxy-methyl, halo, amino, methoxy-carbonyl, 2-hydroxypropan-2-yl, fluoro-ethyl, ethyl and cyclopropyl;  $R_7$  at each occurrence is independently selected from hydroxy, methyl, methoxy, hydroxy-methyl, amino, methyl-amino, amino-methyl, trifluoromethyl, 2-hydroxypropan-2-yl, methyl-carbonyl-amino, dimethyl-amino, cyano and amino-carbonyl; or two  $R_7$  groups combine with the atom to which they are attached to form a ring selected from cyclopropyl, pyrrolo[3,4-c]pyrazol-5(1H,4H,6H)-yl and 3-azabicyclo[3.1.0]hexan-3-yl; wherein said 3-azabicyclo[3.1.0]hexan-3-yl can be optionally substituted with amino;  $Y_1$  is selected from CH and N;  $Y_2$  is selected from  $CF_2$ , O and  $S(O)_{0-2}$ ;  $Y_3$  is selected from hydrogen, fluoro, chloro, methyl, difluoromethyl and trifluoromethyl; or the pharmaceutically acceptable salts thereof.

In a further embodiment are compounds selected from:



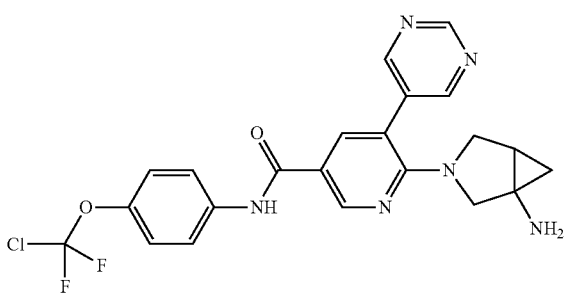
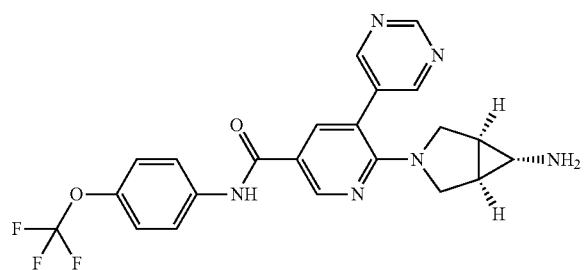
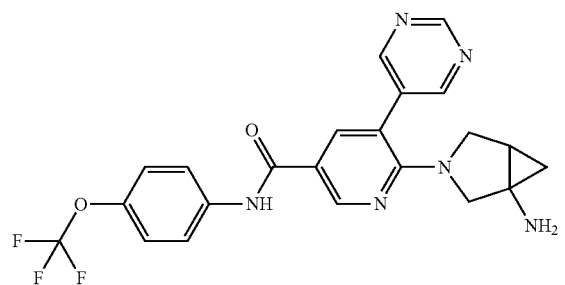
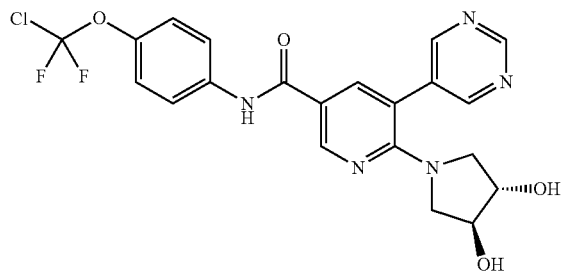
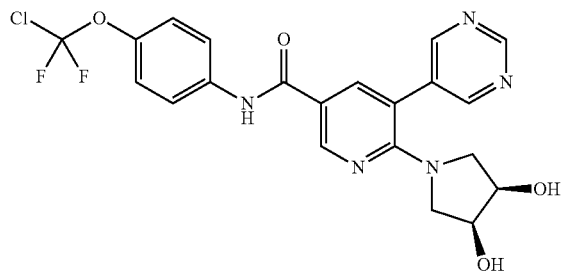
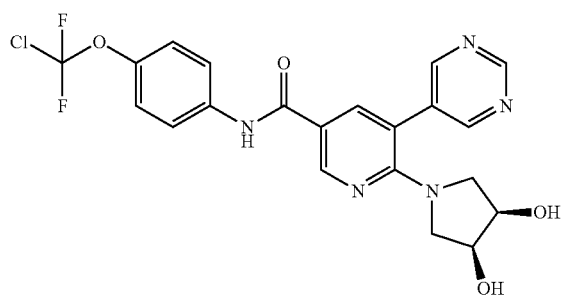
10

-continued

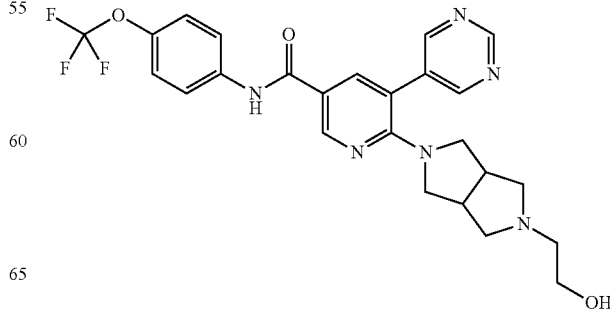
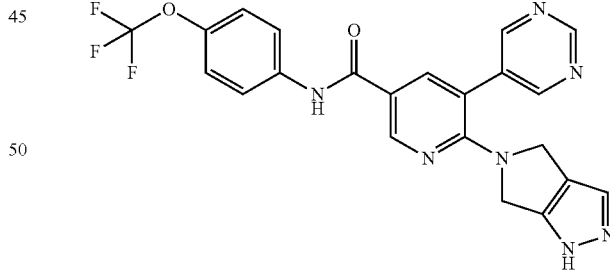
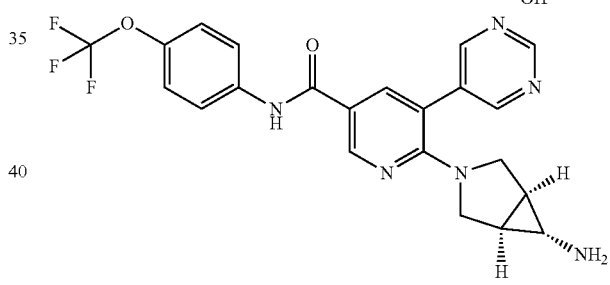
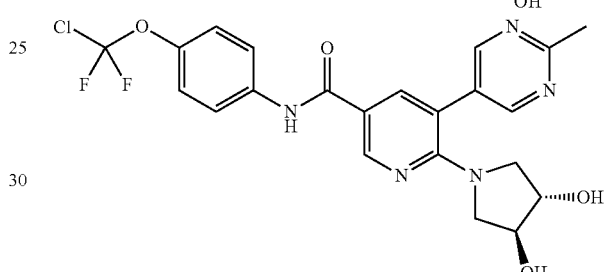
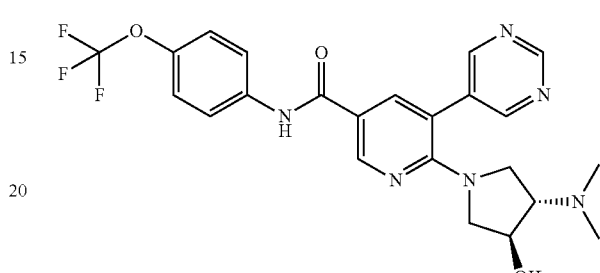
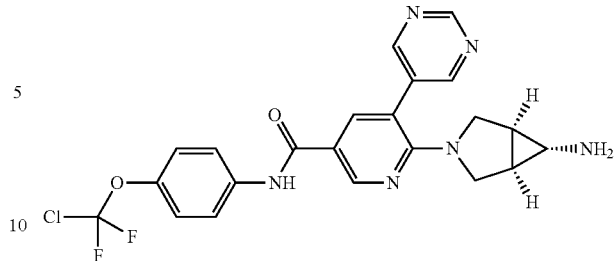


**11**

-continued

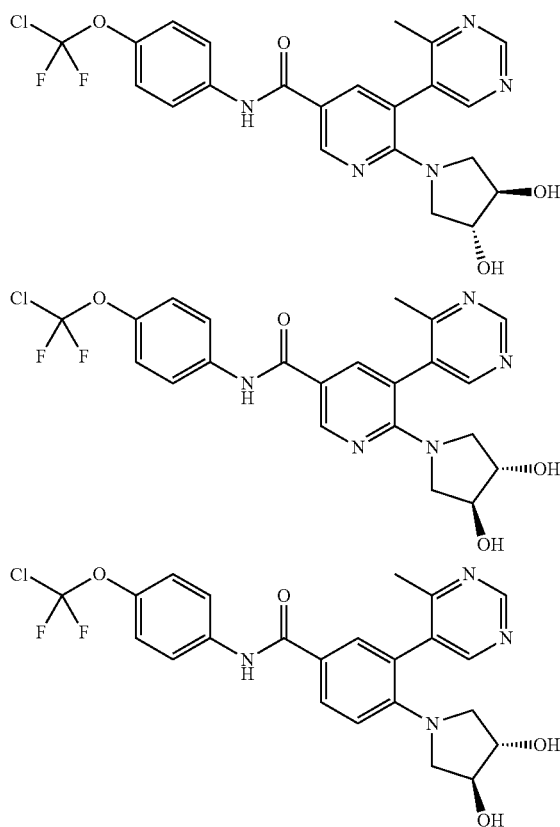
**12**

-continued

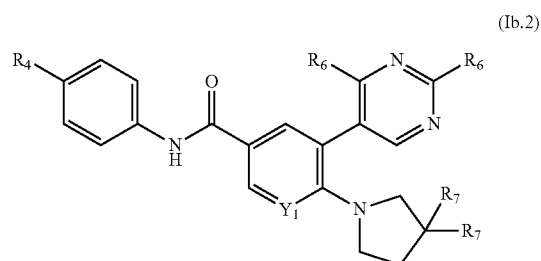


**13**

-continued



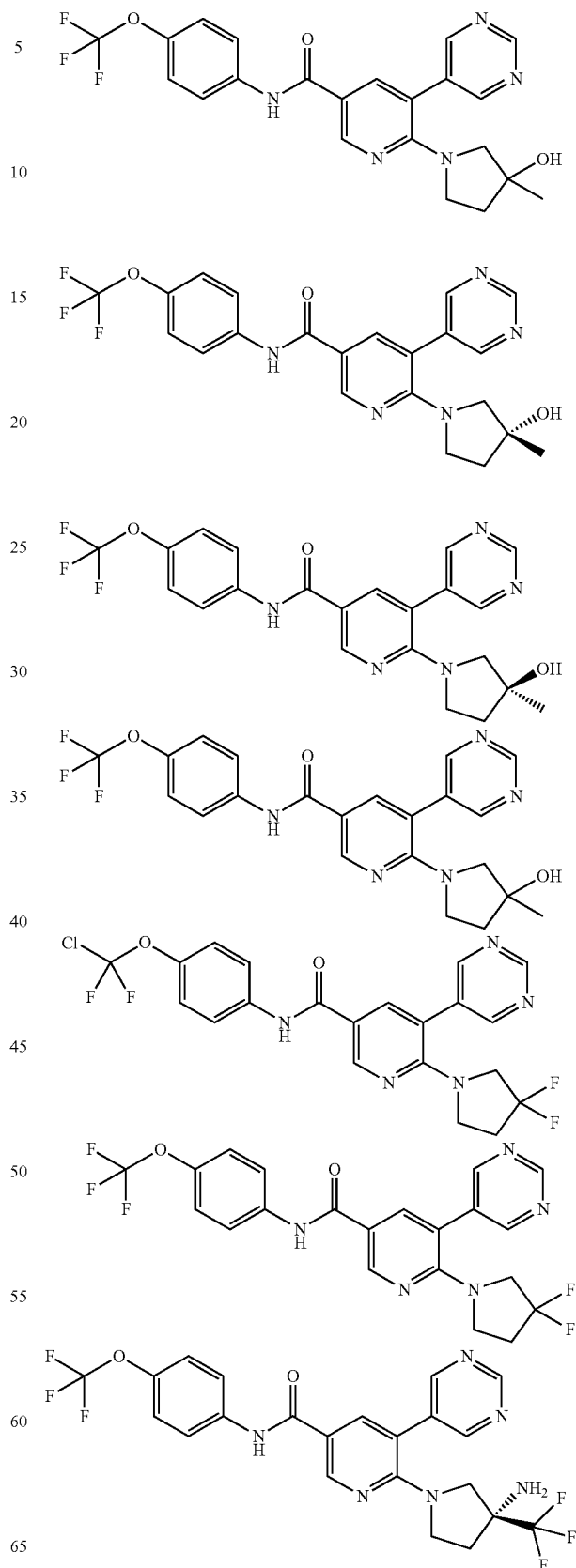
In another embodiment are compounds of formula (Ib.2):



in which:  $R_4$  is selected from  $-\text{SF}_5$  and  $-\text{Y}_2-\text{CF}_2-\text{Y}_3$ ;  $R_6$  at each occurrence is independently selected from hydrogen, methyl, methoxy, cyano, trifluoromethyl, hydroxy-methyl, halo, amino, methoxy-carbonyl, 2-hydroxypropan-2-yl, fluoro-ethyl, ethyl and cyclopropyl;  $R_7$  at each occurrence is independently selected from hydroxy, methyl, methoxy, hydroxy-methyl, amino, methyl-amino, amino-methyl, trifluoromethyl, 2-hydroxypropan-2-yl, methyl-carbonyl-amino, dimethyl-amino, cyano and amino-carbonyl; or two  $R_7$  groups combine with the atom to which they are attached to form a ring selected from cyclopropyl and 3-azabicyclo [3.1.0]hexan-3-yl;  $\text{Y}_1$  is selected from CH and N;  $\text{Y}_2$  is selected from  $\text{CF}_2$ , O and  $\text{S}(\text{O})_{0-2}$ ;  $\text{Y}_3$  is selected from hydrogen, fluoro, chloro, methyl, difluoromethyl and trifluoromethyl; or the pharmaceutically acceptable salts thereof.

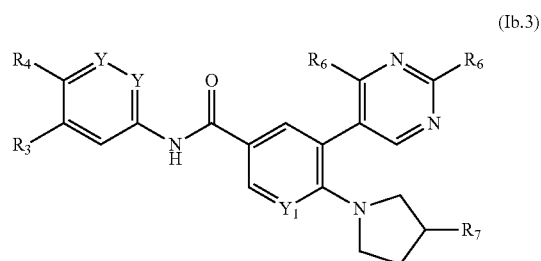
**14**

In a further embodiment are compounds selected from:



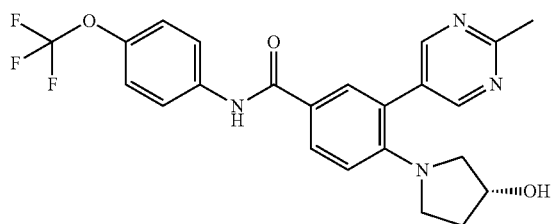
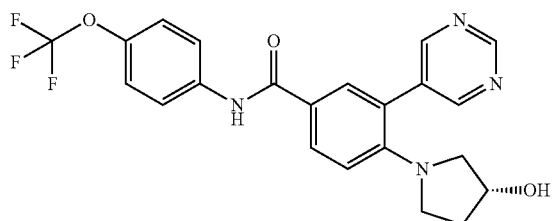
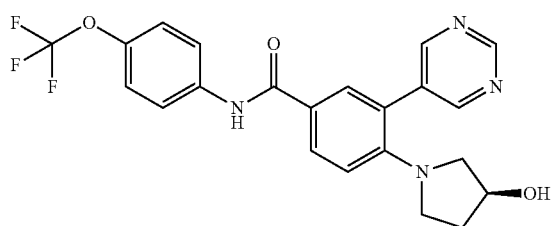
**15**

In another embodiment are compounds of formula (Ib.3):

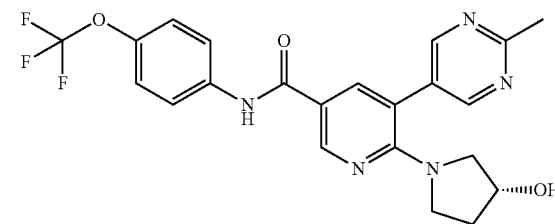
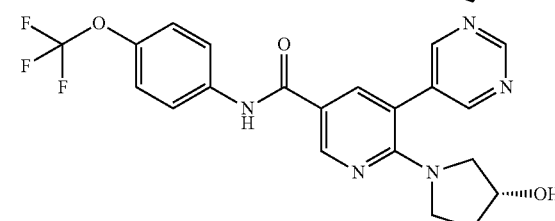
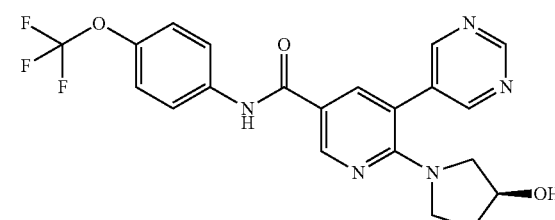
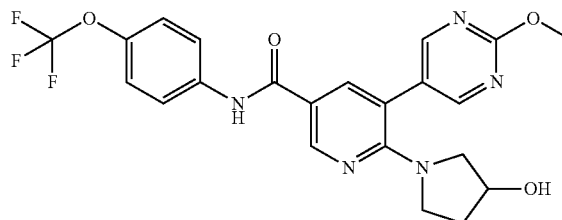
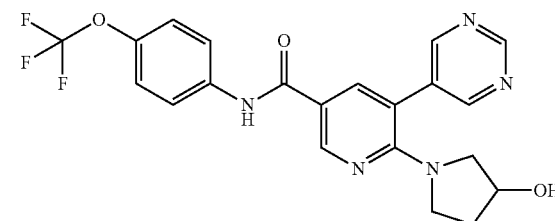
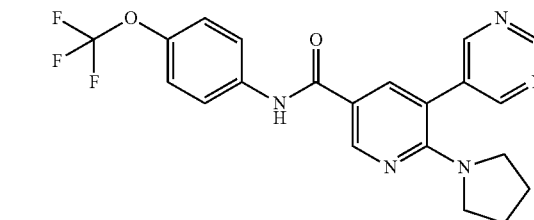
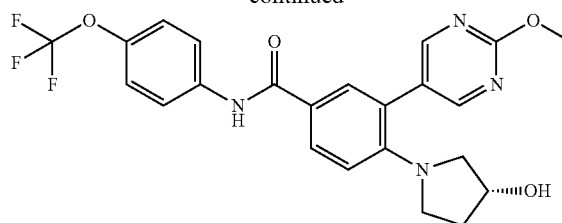


in which: Y is selected from CH and N; R<sub>3</sub> is selected from hydrogen and halo; R<sub>4</sub> is selected from —SF<sub>5</sub> and —Y<sub>2</sub>—CF<sub>2</sub>—Y<sub>3</sub>; R<sub>6</sub> at each occurrence is independently selected from hydrogen, methyl, methoxy-carbonyl, 2-hydroxypropan-2-yl, methoxy, cyano, trifluoromethyl, hydroxy-methyl, halo, amino, fluoro-ethyl, ethyl and cyclopropyl; R<sub>7</sub> at each occurrence is independently selected from hydroxy, methyl, methoxy, hydroxy-methyl, amino, methyl-amino, amino-methyl, trifluoromethyl, 2-hydroxypropan-2-yl, methyl-carbonyl-amino, dimethyl-amino, cyano and amino-carbonyl; or two R<sub>7</sub> groups combine with the atom to which they are attached to form a ring selected from cyclopropyl and 3-azabicyclo[3.1.0]hexan-3-yl; Y<sub>1</sub> is selected from CH and N; Y<sub>2</sub> is selected from CF<sub>2</sub>, O and S(O)<sub>0-2</sub>; Y<sub>3</sub> is selected from hydrogen, fluoro, chloro, methyl, difluoromethyl and trifluoromethyl; or the pharmaceutically acceptable salts thereof.

In a further embodiment are compounds selected from:

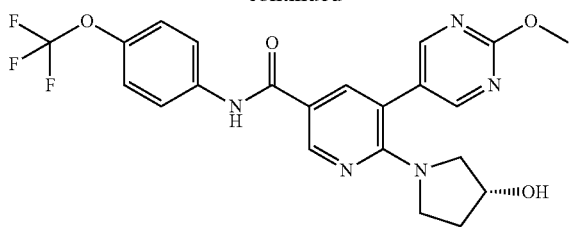
**16**

-continued



17

-continued

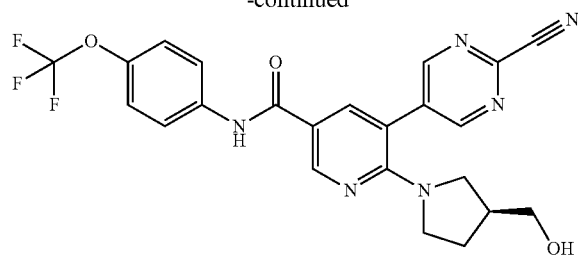


5

10

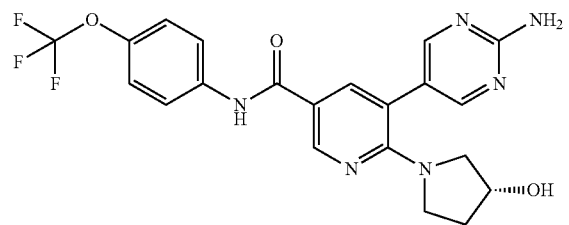
18

-continued



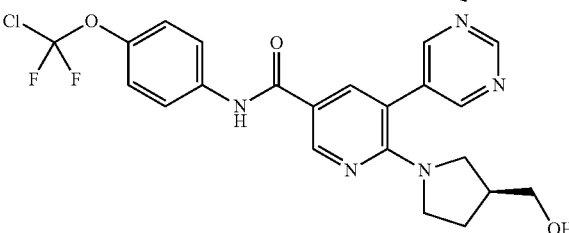
15

20



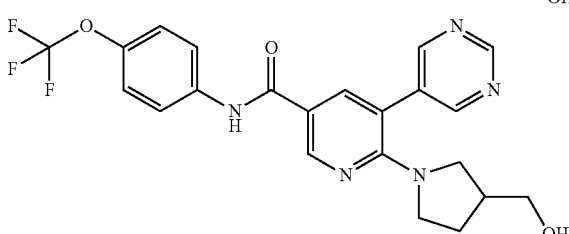
25

30



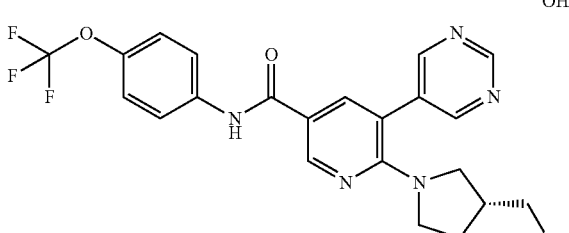
35

40



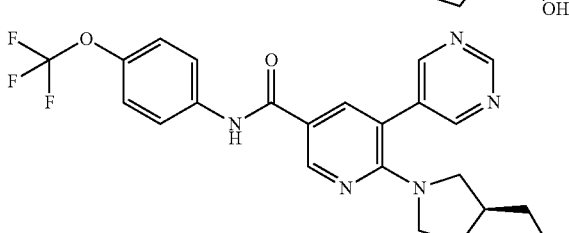
45

50

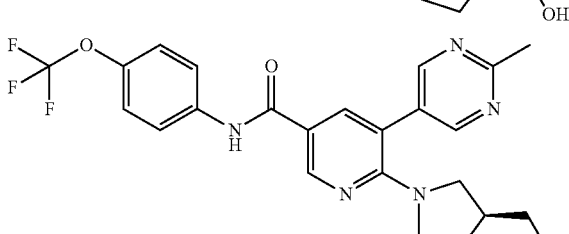


55

60

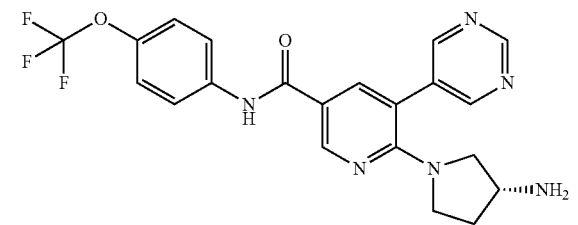


65



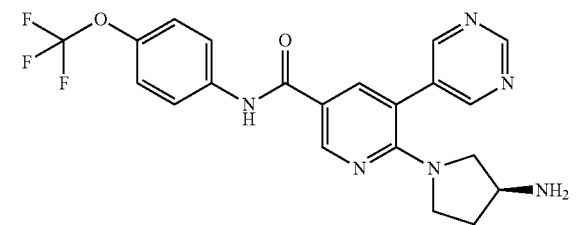
60

65



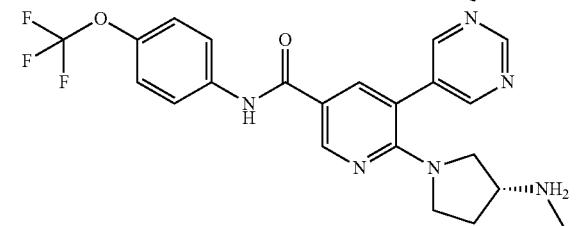
25

30



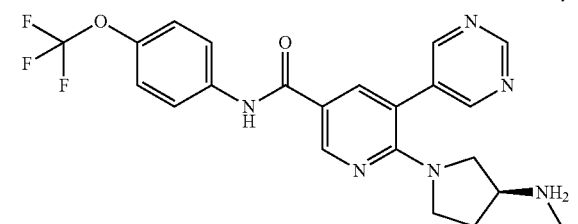
35

40



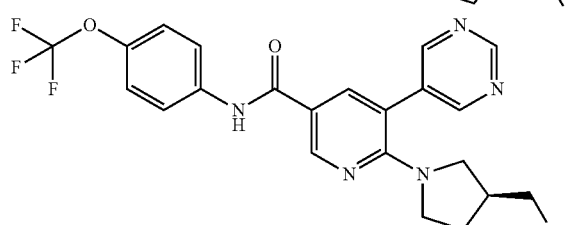
45

50



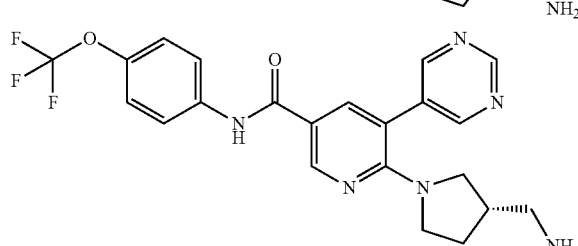
55

60



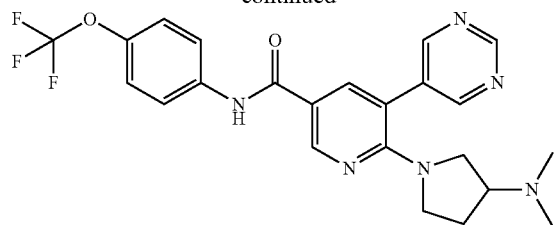
60

65



**19**

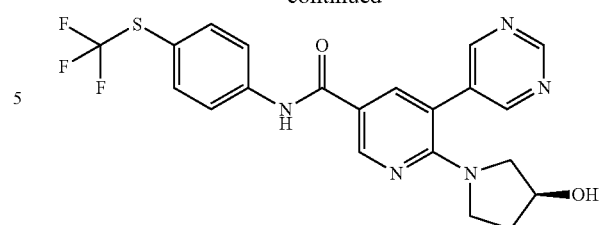
-continued



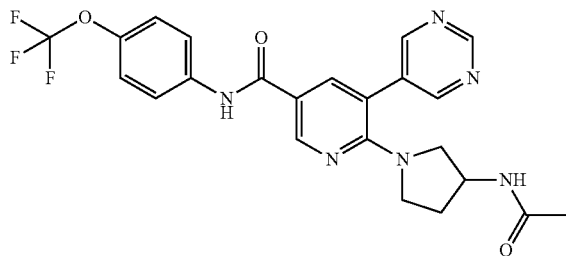
10

**20**

-continued

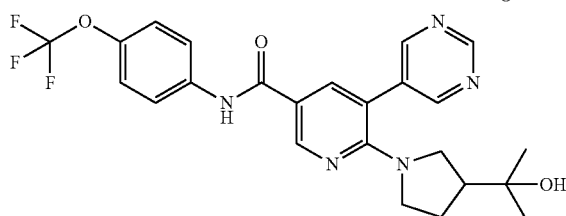


10



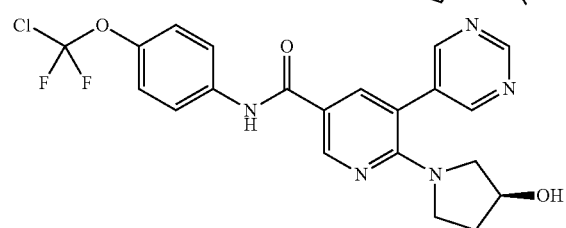
20

20



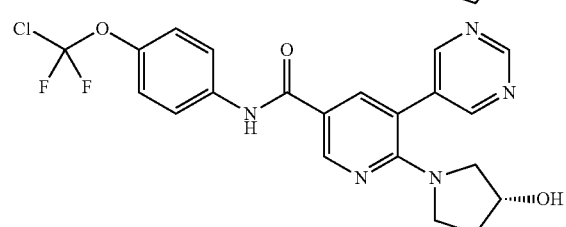
30

30



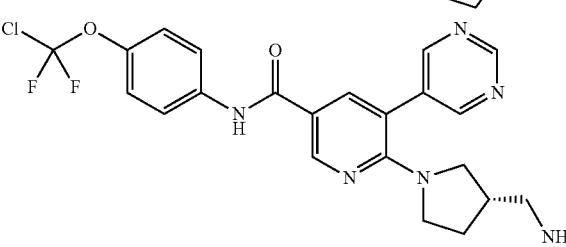
35

35



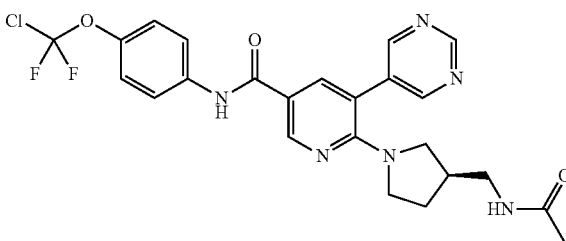
40

40



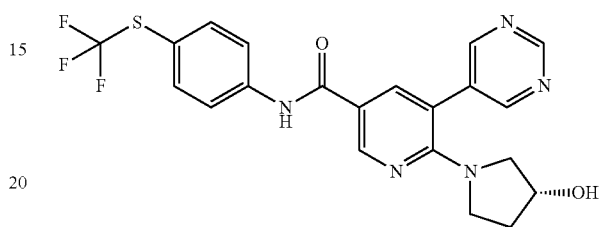
55

55



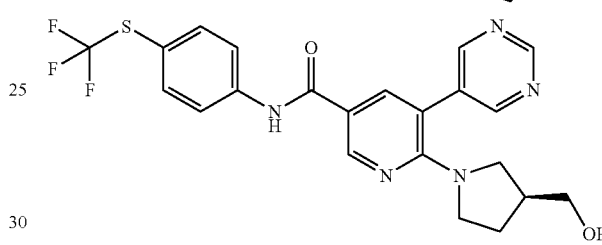
65

65



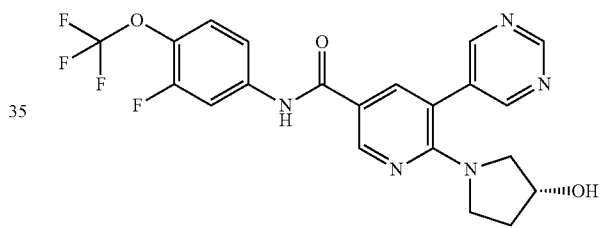
15

15



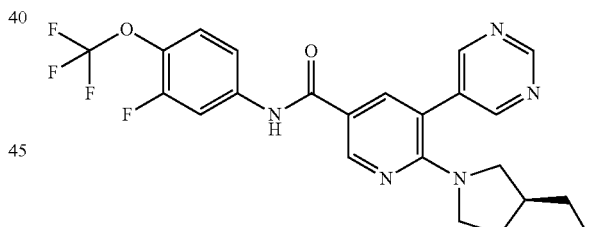
25

25



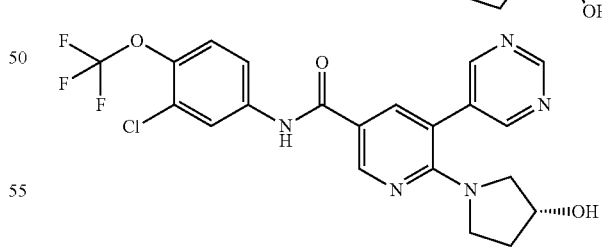
35

35



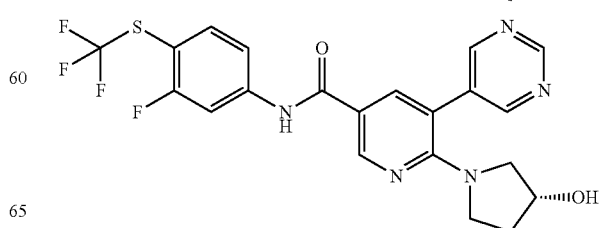
40

40



50

50

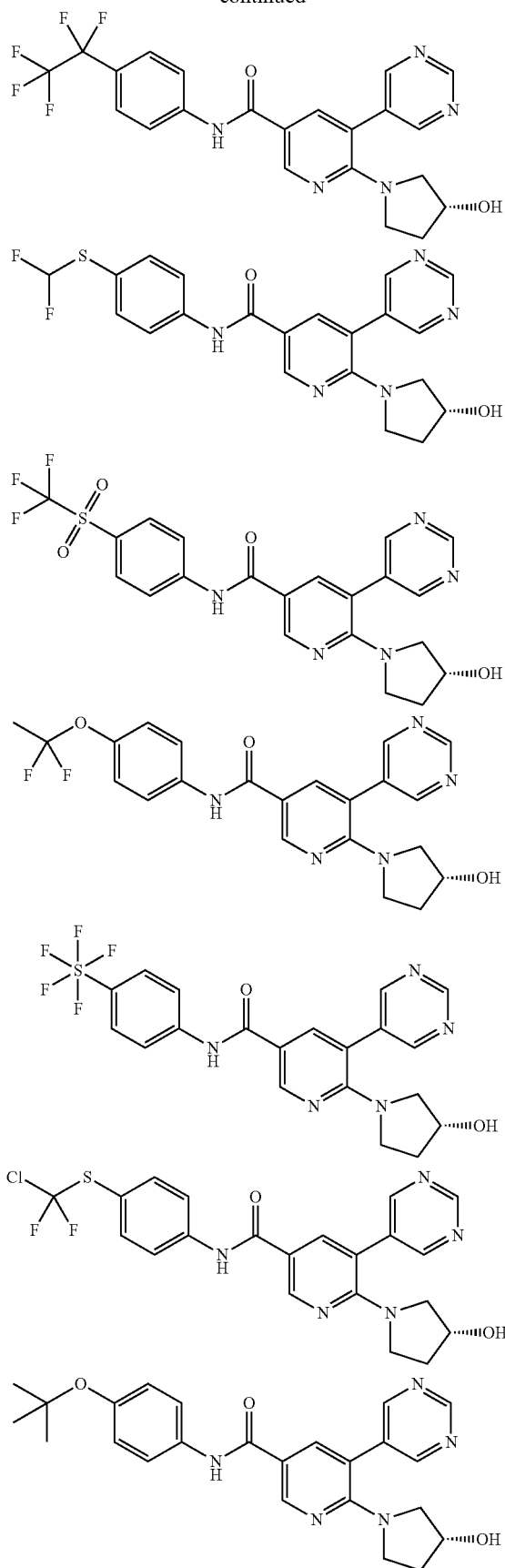


60

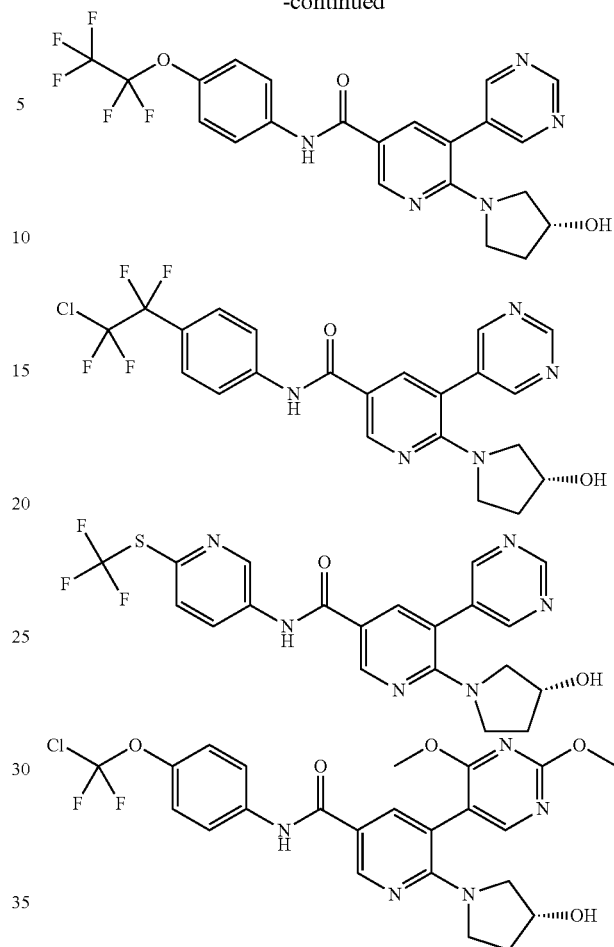
60

**21**

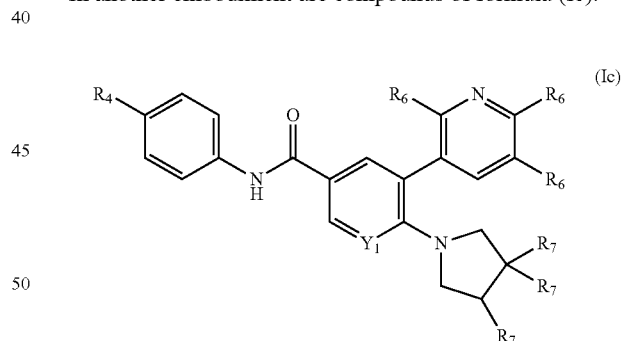
-continued

**22**

-continued



In another embodiment are compounds of formula (Ic):

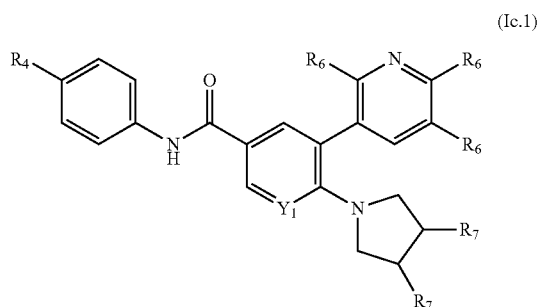


in which:  $R_4$  is selected from  $-\text{SF}_5$  and  $-\text{Y}_2-\text{CF}_2-\text{Y}_3$ ;  $R_6$  at each occurrence is independently selected from hydrogen, methyl, methoxy, methoxy-carbonyl, 2-hydroxypropan-2-yl, cyano, trifluoromethyl, hydroxy-methyl, halo, amino, fluoro-ethyl, ethyl and cyclopropyl;  $R_7$  at each occurrence is independently selected from hydroxy, methyl, methoxy, hydroxy-methyl, amino, methyl-amino, amino-methyl, trifluoromethyl, 2-hydroxypropan-2-yl, methyl-carbonyl-amino, dimethyl-amino, cyano and amino-carbonyl; or two  $R_7$  groups combine with the atom to which they are attached to form a ring selected from cyclopropyl and 3-azabicyclo [3.1.0]hexan-3-yl;  $\text{Y}_1$  is selected from CH and N;  $\text{Y}_2$  is

**23**

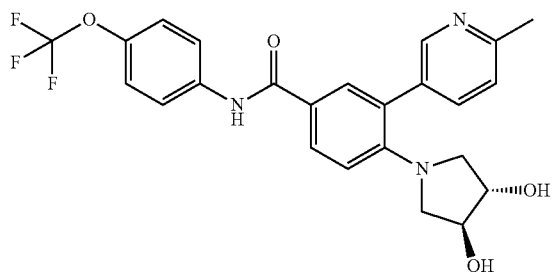
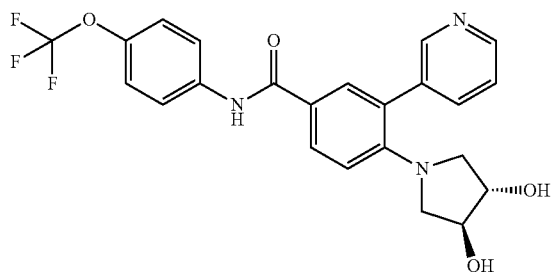
selected from  $\text{CF}_2$ , O and  $\text{S}(\text{O})_{0-2}$ ;  $\text{Y}_3$  is selected from hydrogen, fluoro, chloro, methyl, difluoromethyl and trifluoromethyl; or the pharmaceutically acceptable salts thereof.

In another embodiment are compounds of formula (Ic.1):

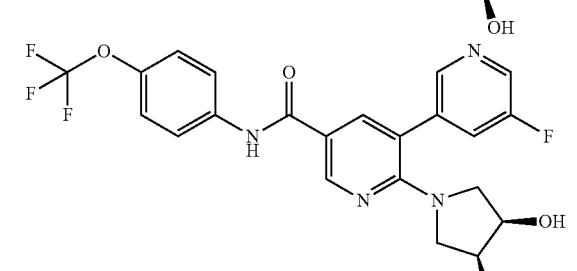
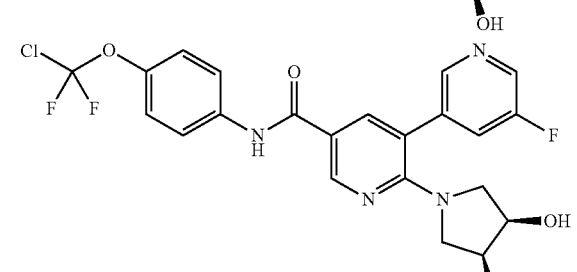
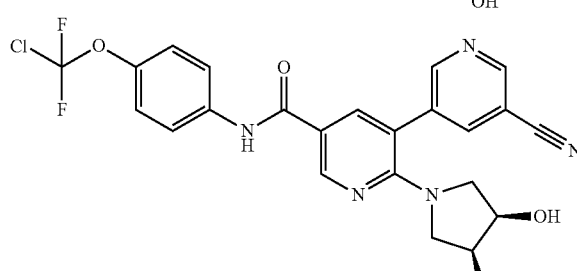
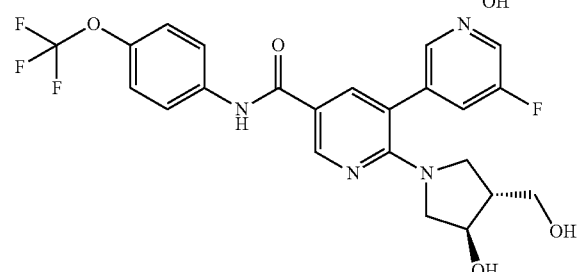
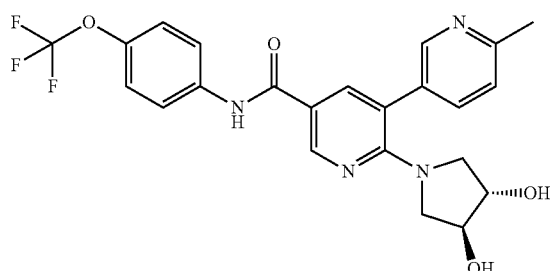
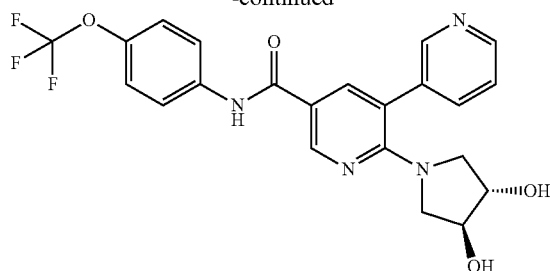


in which:  $\text{R}_4$  is selected from  $-\text{SF}_5$  and  $-\text{Y}_2-\text{CF}_2-\text{Y}_3$ ;  $\text{R}_6$  at each occurrence is independently selected from hydrogen, methyl, methoxy, methoxy-carbonyl, 2-hydroxypropan-2-yl, cyano, trifluoromethyl, hydroxy-methyl, halo, amino, fluoro-ethyl, ethyl and cyclopropyl;  $\text{R}_7$  at each occurrence is independently selected from hydroxy, methyl, methoxy, hydroxy-methyl, amino, methyl-amino, amino-methyl, trifluoromethyl, 2-hydroxypropan-2-yl, methyl-carbonyl-amino, dimethyl-amino, cyano and amino-carbonyl; or two  $\text{R}_7$  groups combine with the atom to which they are attached to form a ring selected from cyclopropyl and 3-azabicyclo [3.1.0]hexan-3-yl;  $\text{Y}_1$  is selected from CH and N;  $\text{Y}_2$  is selected from  $\text{CF}_2$ , O and  $\text{S}(\text{O})_{0-2}$ ;  $\text{Y}_3$  is selected from hydrogen, fluoro, chloro, methyl, difluoromethyl and trifluoromethyl; or the pharmaceutically acceptable salts thereof.

In a further embodiment are compounds selected from:

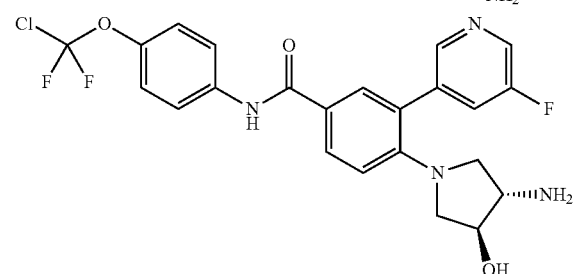
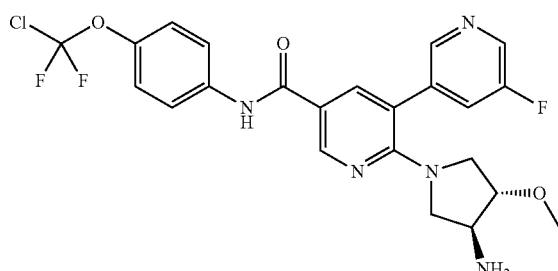
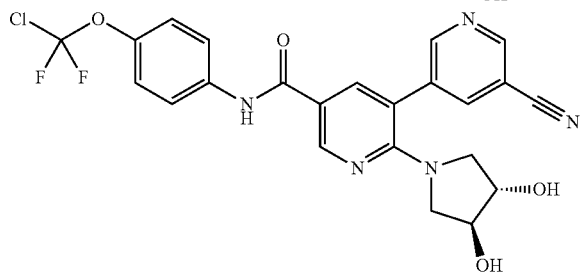
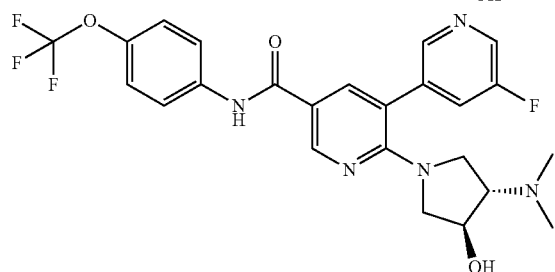
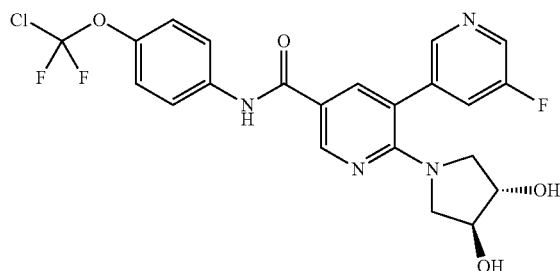
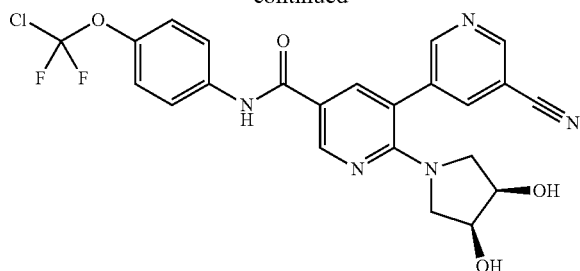
**24**

-continued

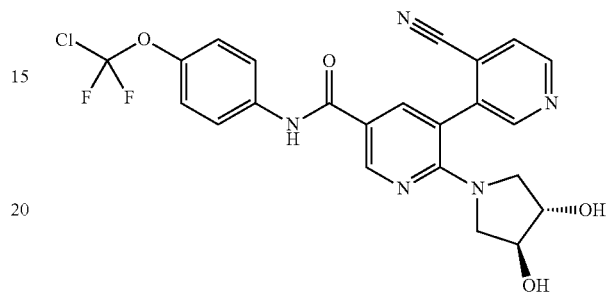
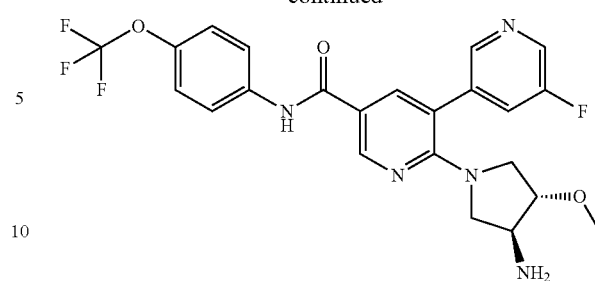


**25**

-continued

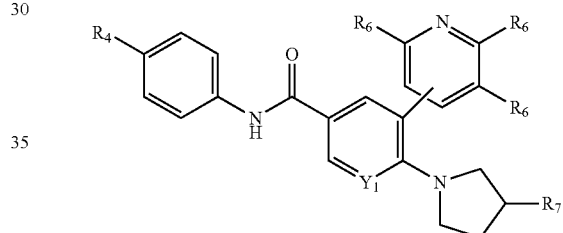
**26**

-continued



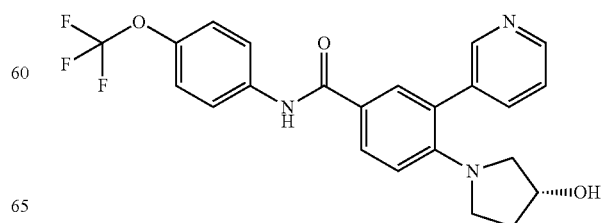
In another embodiment are compounds of formula (Ic.2):

(Ic.2)



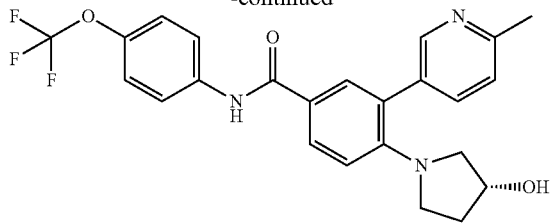
in which:  $R_4$  is selected from  $-\text{SF}_5$  and  $-\text{Y}_2-\text{CF}_2-\text{Y}_3$ ;  $R_6$  at each occurrence is independently selected from hydrogen, methyl, methoxy, methoxy-carbonyl, 2-hydroxypropan-2-yl, cyano, trifluoromethyl, hydroxy-methyl, halo, amino, fluoro-ethyl, ethyl and cyclopropyl;  $R_7$  at each occurrence is independently selected from hydroxy, methyl, methoxy, hydroxy-methyl, amino, methyl-amino, amino-methyl, trifluoromethyl, 2-hydroxypropan-2-yl, methyl-carbonyl-amino, dimethyl-amino, cyano and amino-carbonyl; or two  $R_7$  groups combine with the atom to which they are attached to form a ring selected from cyclopropyl and 3-azabicyclo [3.1.0]hexan-3-yl;  $Y_1$  is selected from CH and N;  $Y_2$  is selected from  $\text{CF}_2$ , O and  $\text{S}(\text{O})_{0.2}$ ;  $Y_3$  is selected from hydrogen, fluoro, chloro, methyl, difluoromethyl and trifluoromethyl; or the pharmaceutically acceptable salts thereof.

In a further embodiment are compounds selected from:



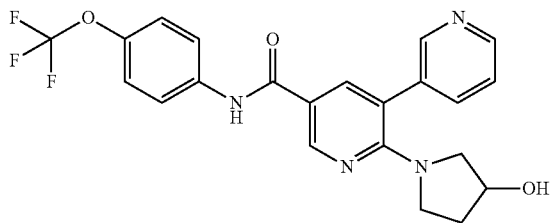
27

-continued



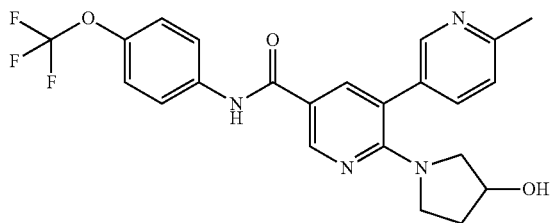
5

10



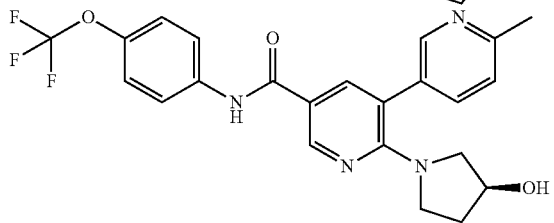
15

20



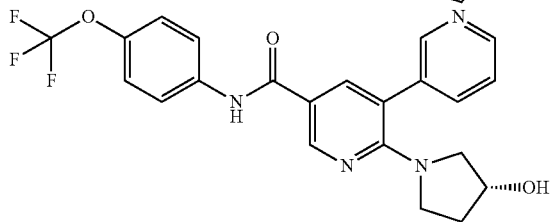
25

30



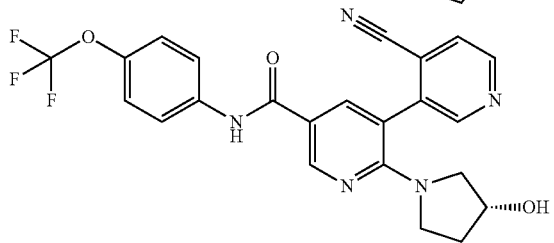
35

40



45

50



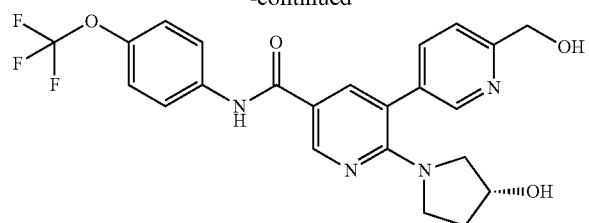
55

60

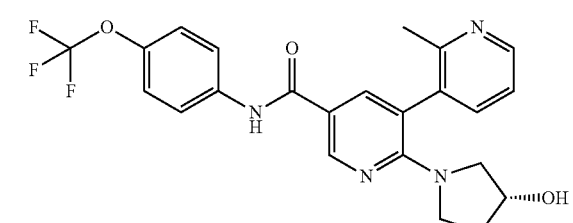
65

28

-continued

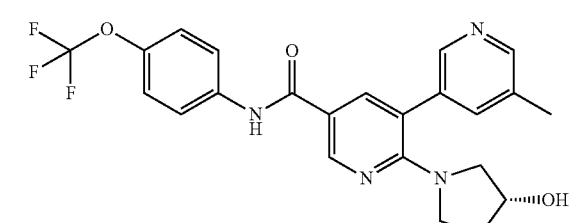


10



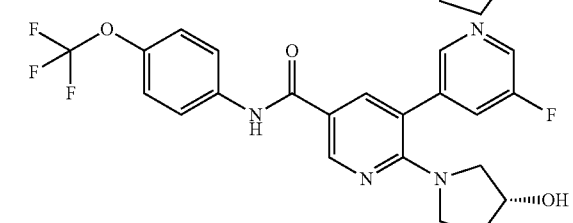
15

20



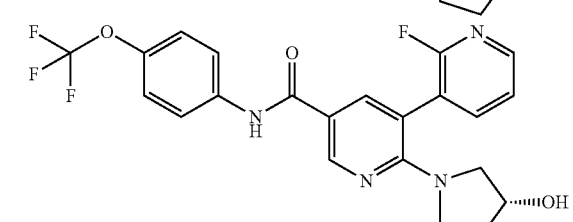
25

30



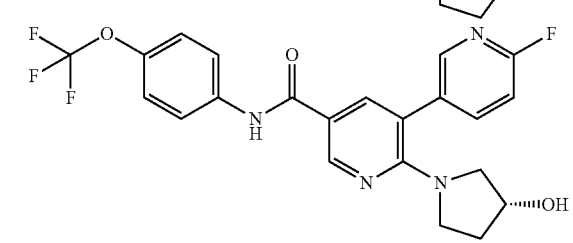
35

40



45

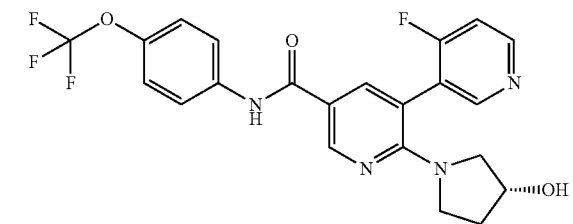
50



55

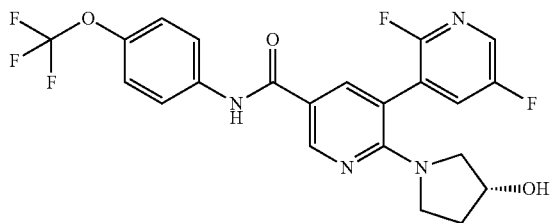
60

65



## 29

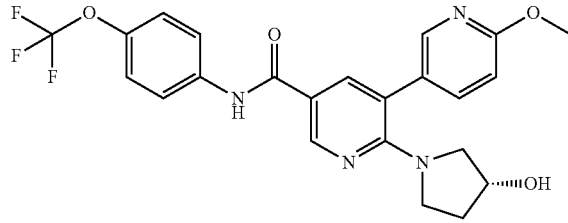
-continued



10

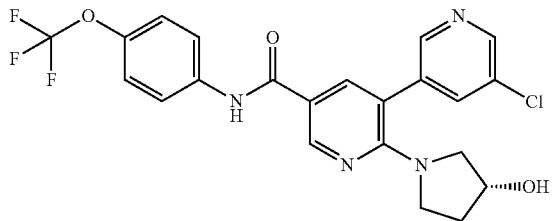
## 30

-continued

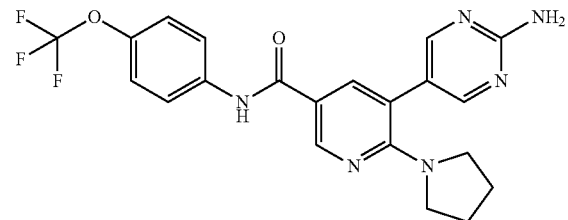


5

10

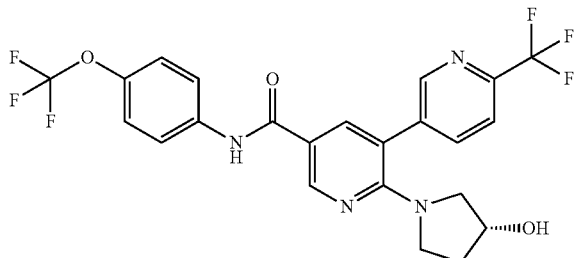


20



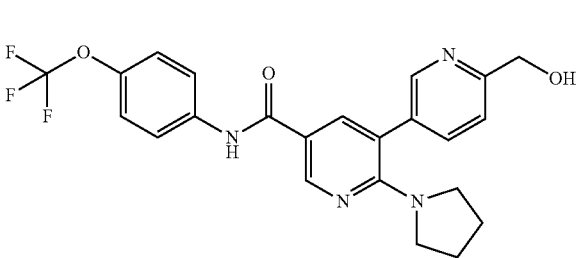
15

20



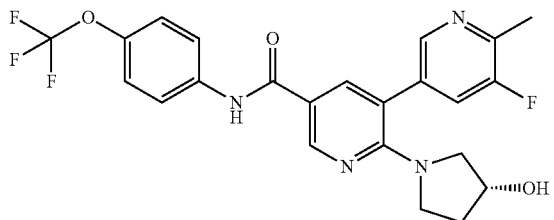
25

30



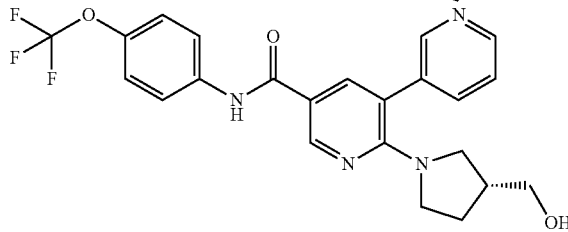
30

30



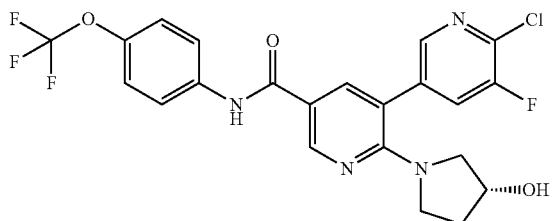
35

40



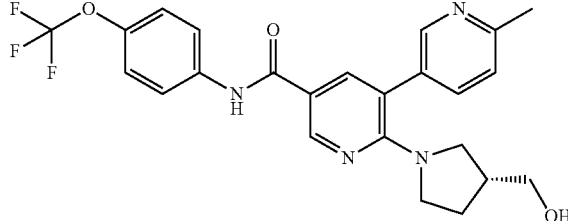
40

40



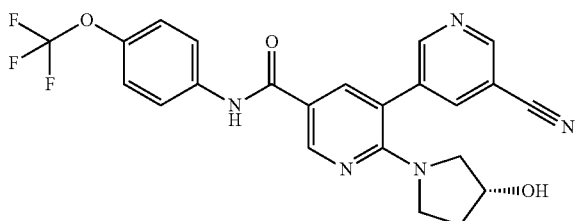
45

45



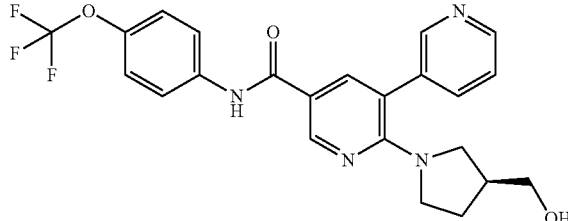
45

45



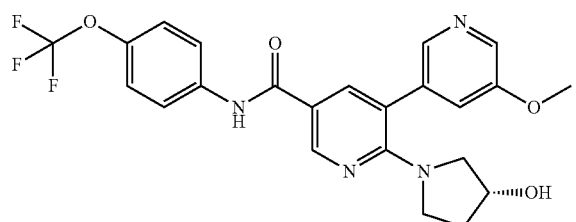
55

55



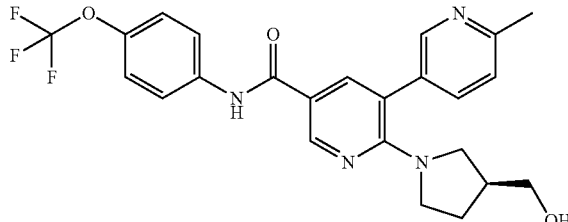
55

55



65

65

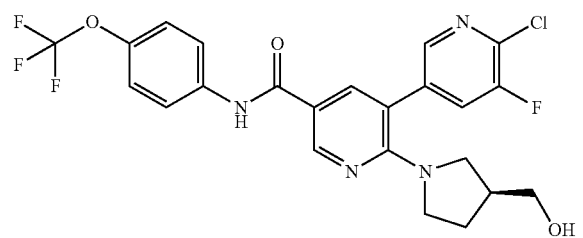
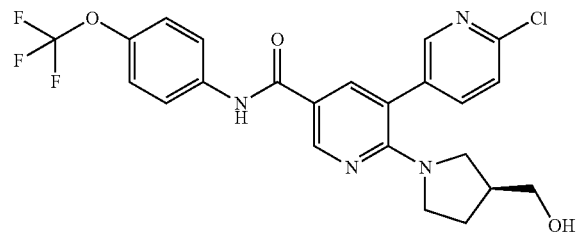
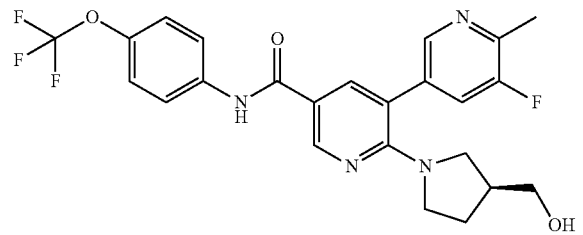
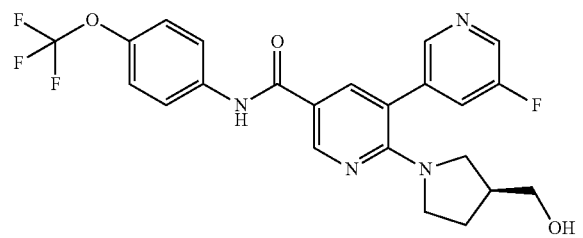
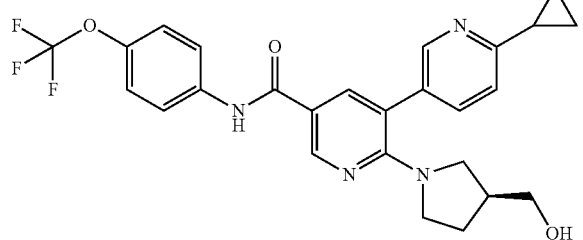
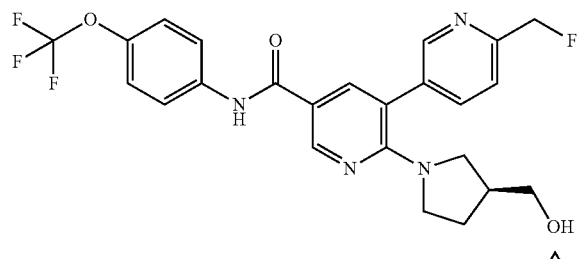
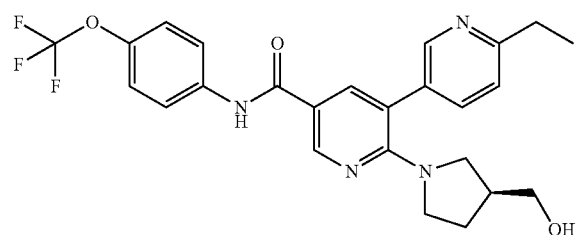


65

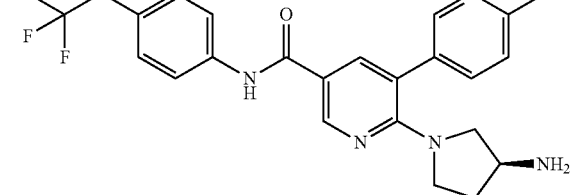
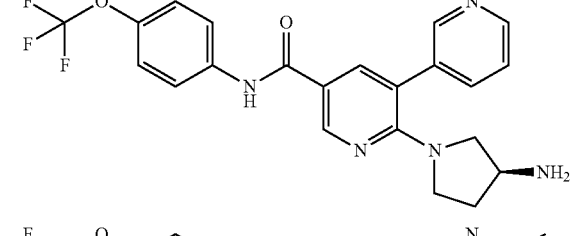
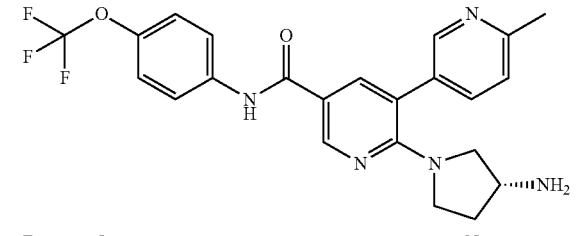
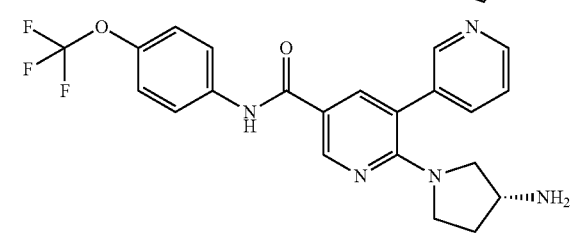
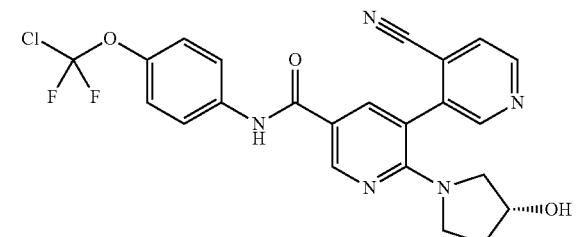
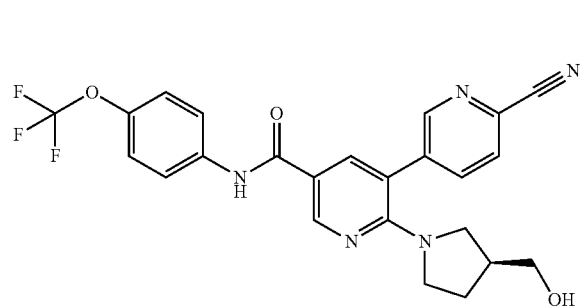
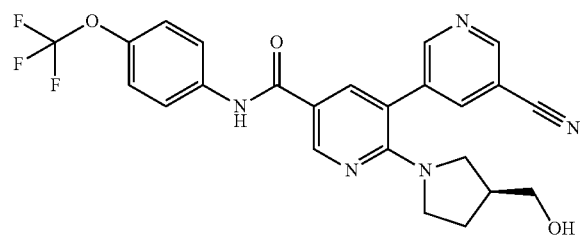
65

**31**

-continued

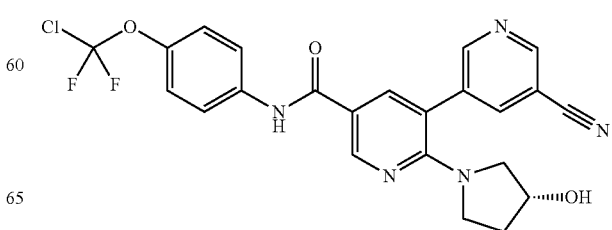
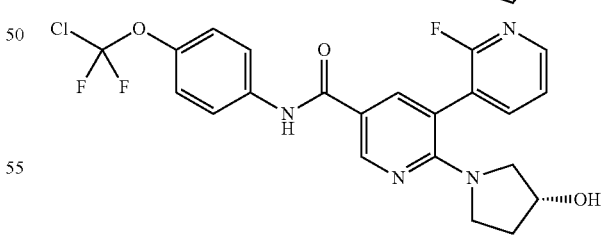
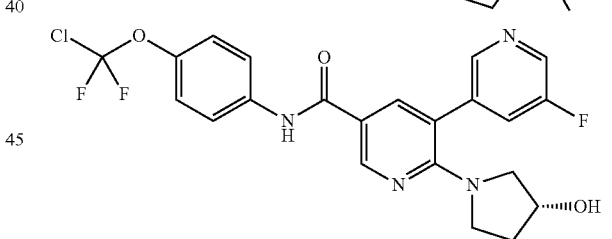
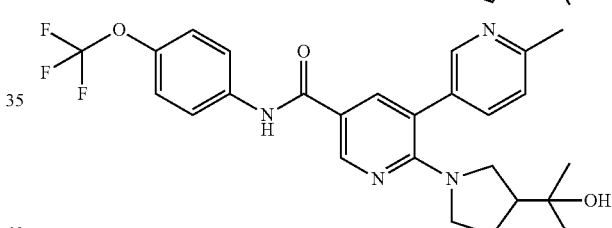
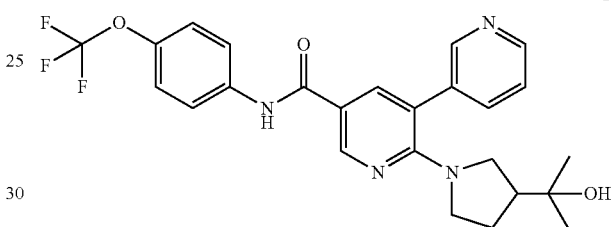
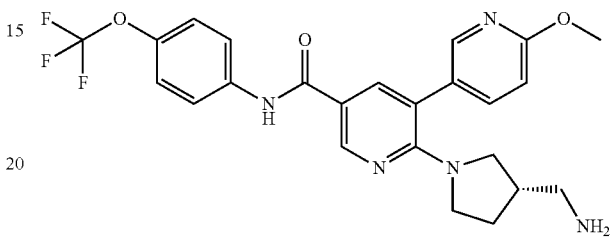
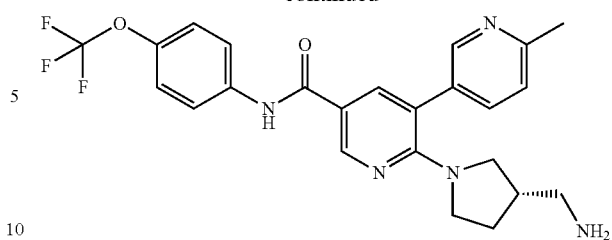
**32**

-continued



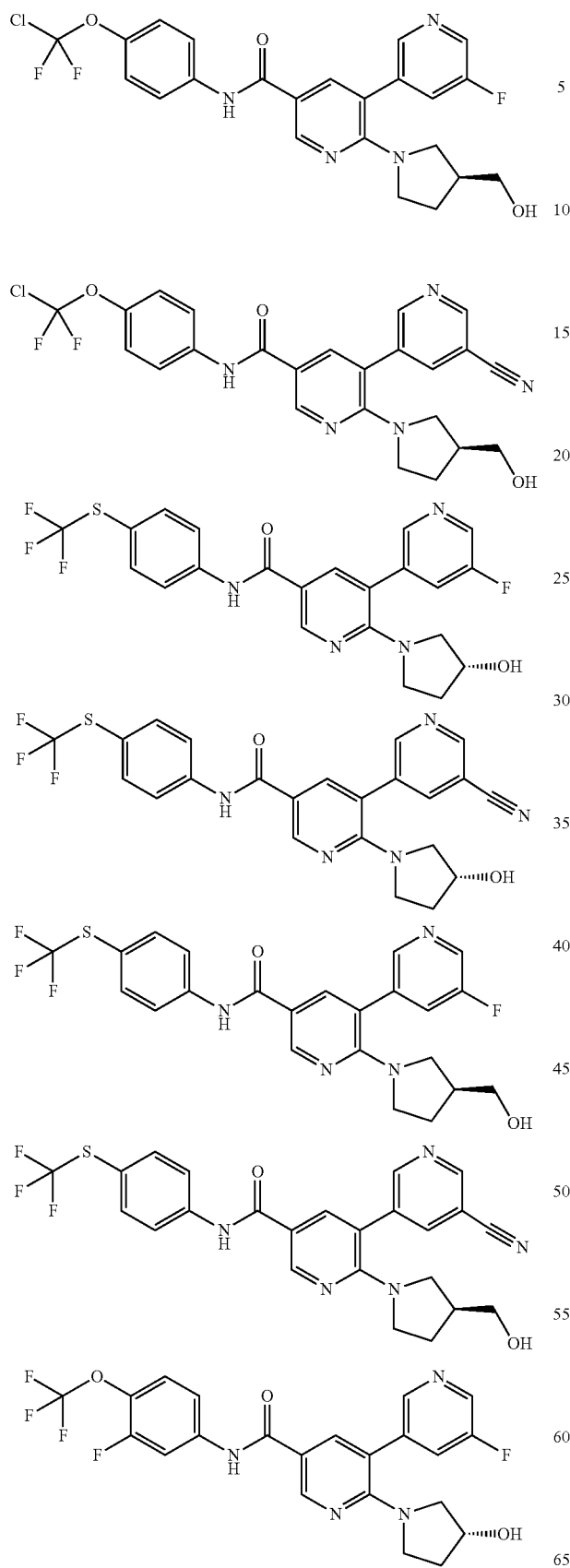
## 34

-continued

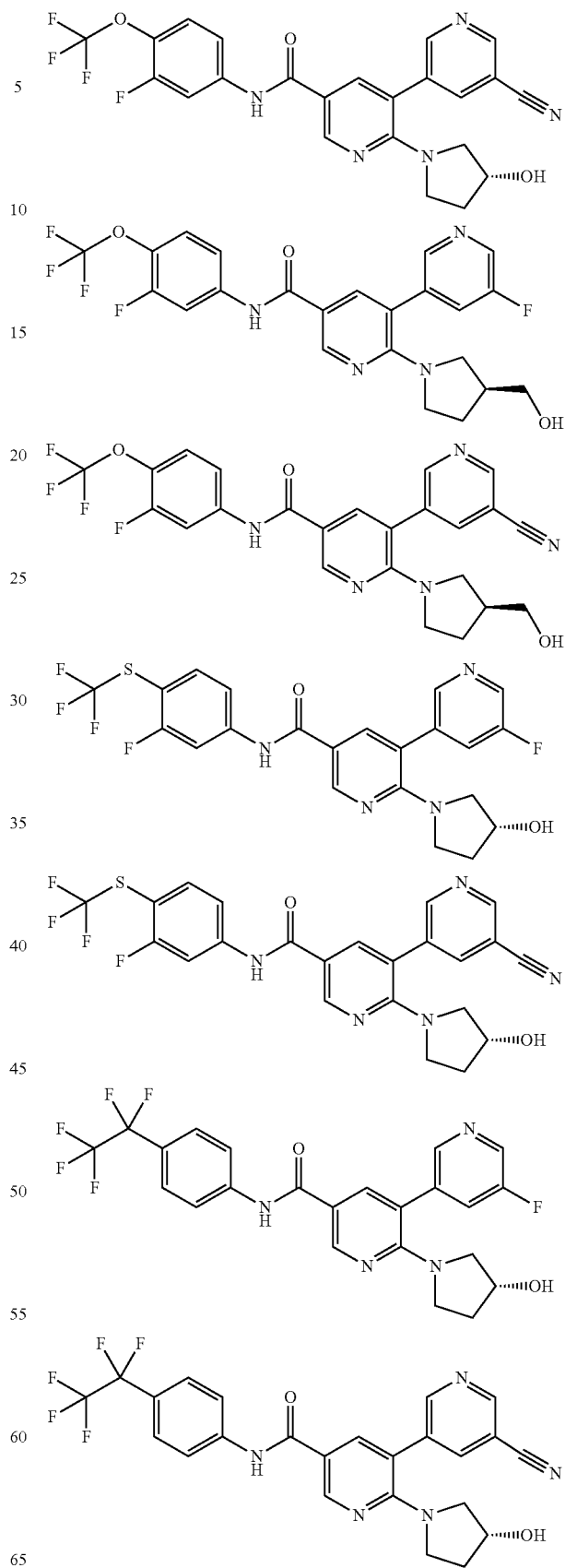


**35**

-continued

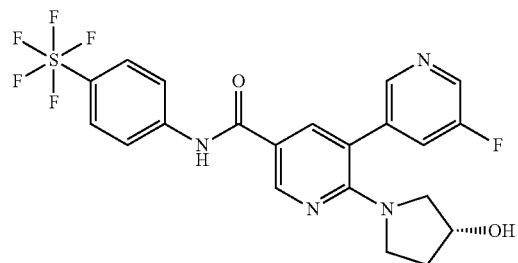
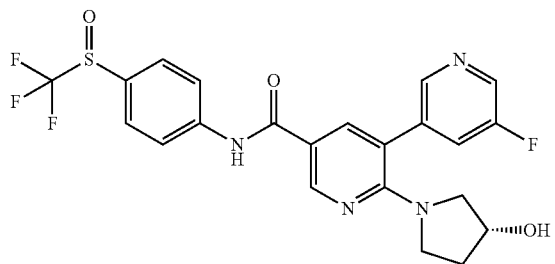
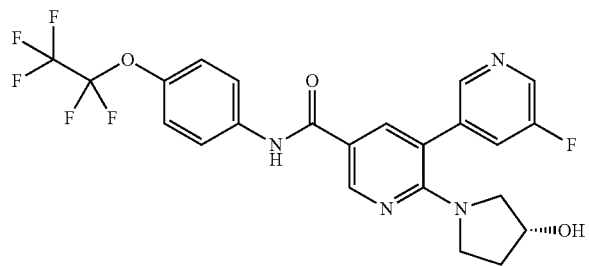
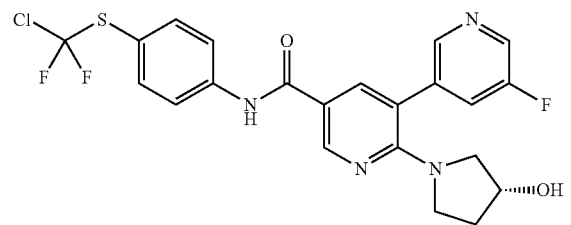
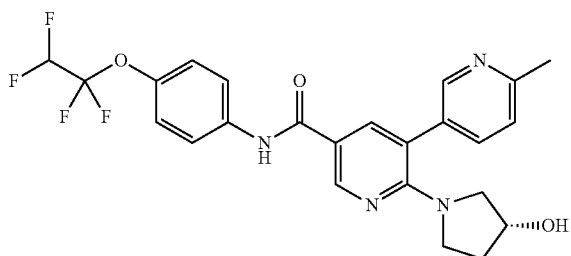
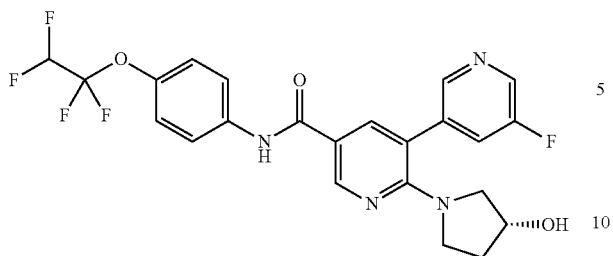
**36**

-continued

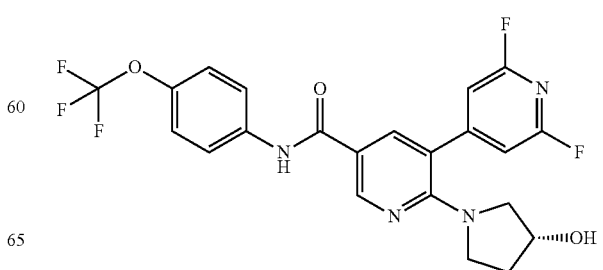
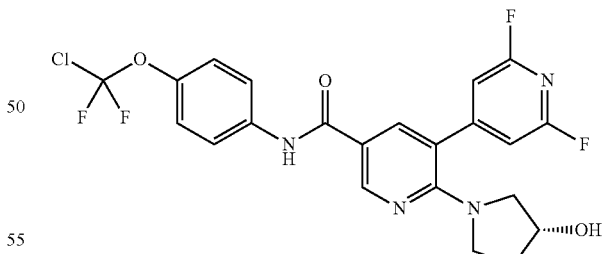
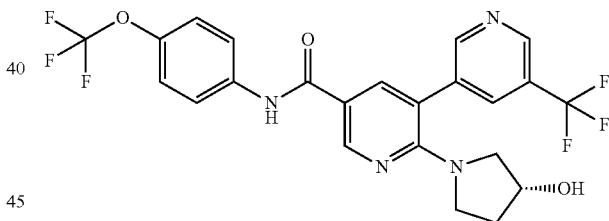
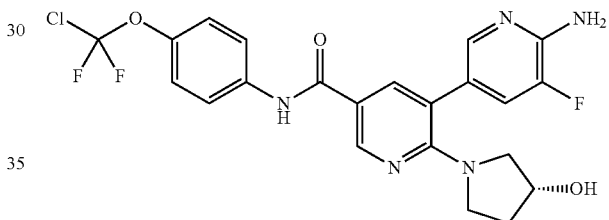
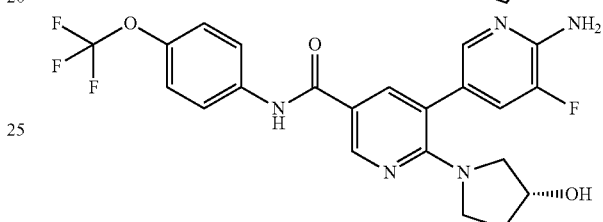
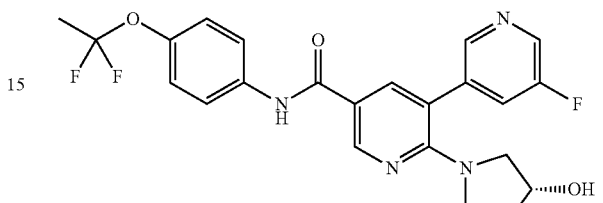
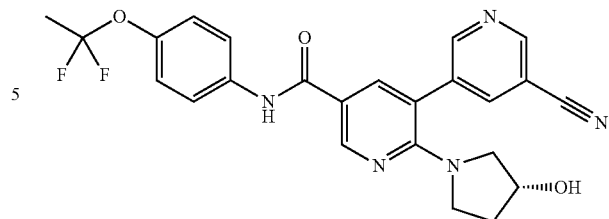


**37**

-continued

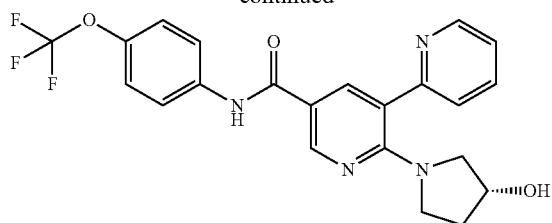
**38**

-continued



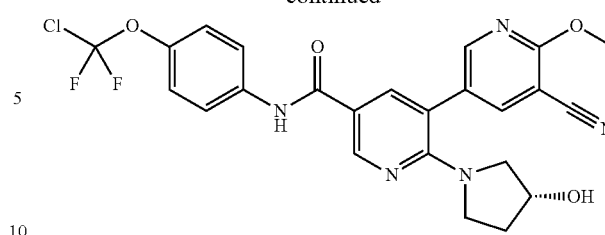
39

-continued

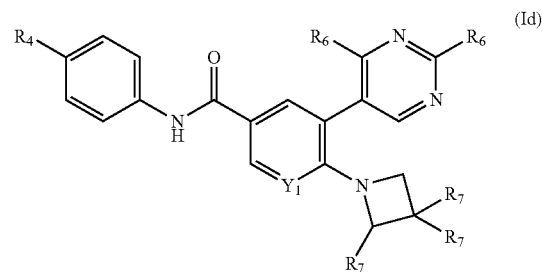
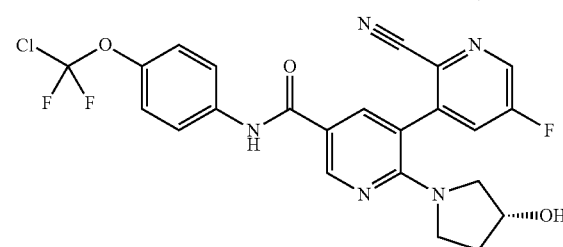
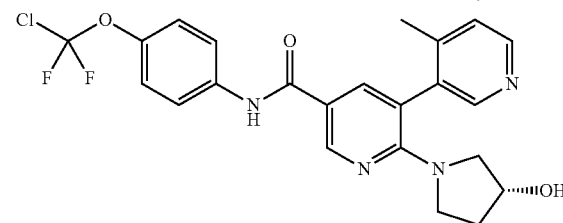
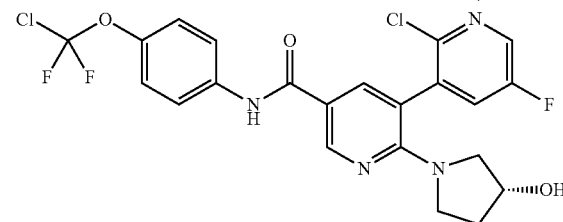
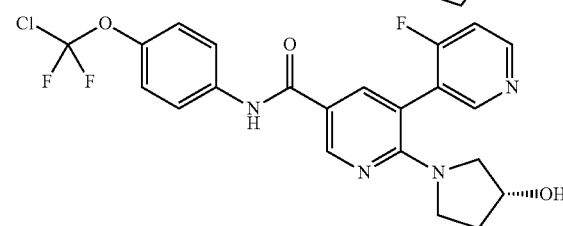
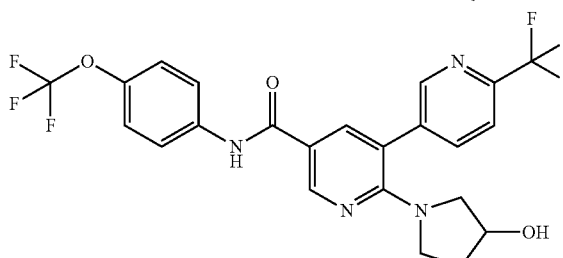
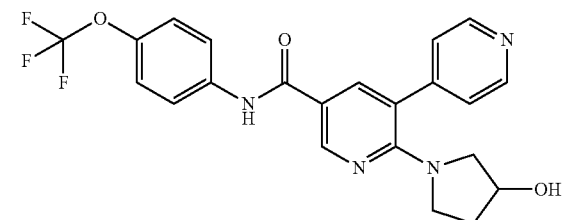


40

-continued

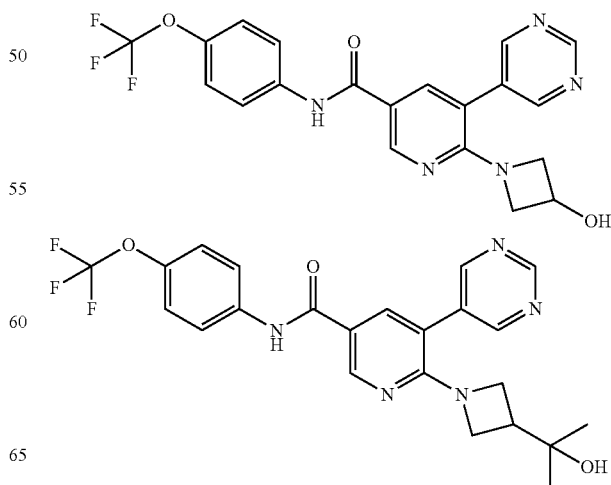


In a further embodiment are compounds of formula (Id):



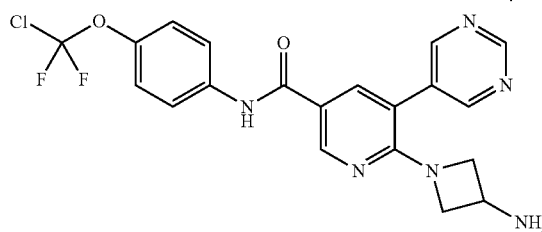
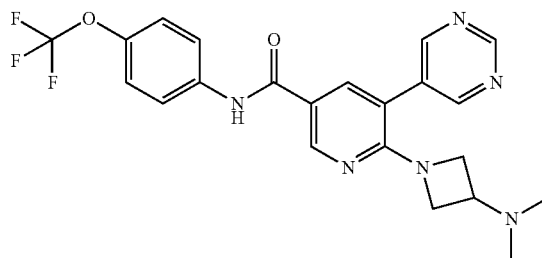
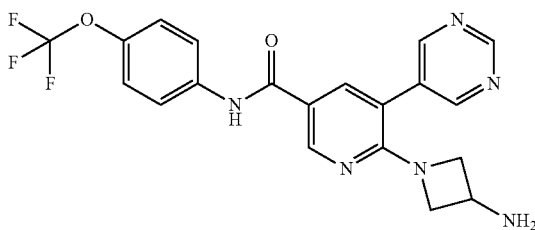
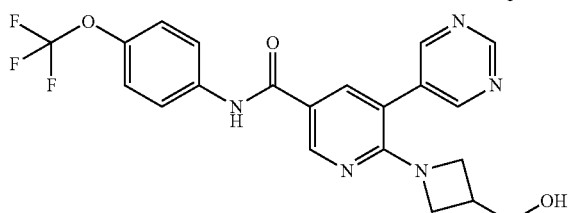
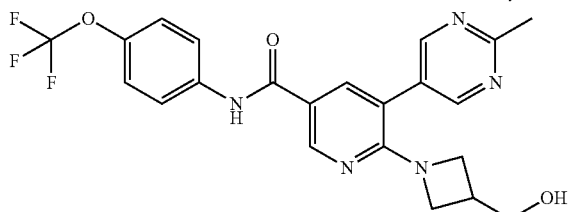
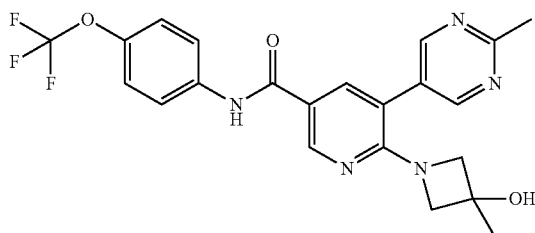
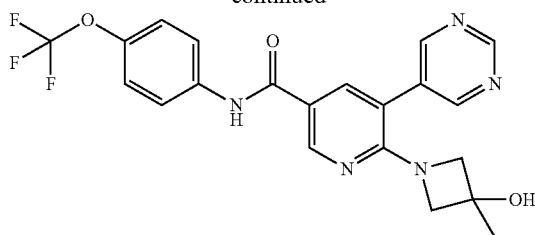
in which:  $R_4$  is selected from  $-\text{SF}_5$  and  $-\text{Y}_2-\text{CF}_2-\text{Y}_3$ ;  $R_6$  at each occurrence is independently selected from hydrogen, methyl, methoxy-carbonyl, 2-hydroxypropan-2-yl, methoxy, cyano, trifluoromethyl, hydroxy-methyl, halo, amino, fluoro-ethyl, ethyl and cyclopropyl;  $R_7$  at each occurrence is independently selected from hydroxy, methyl, methoxy, hydroxy-methyl, amino, methyl-amino, amino-methyl, trifluoromethyl, 2-hydroxypropan-2-yl, methyl-carbonyl-amino, dimethyl-amino, cyano and amino-carbonyl; or two  $R_7$  groups combine with the atom to which they are attached to form a ring selected from cyclopropyl and 3-azabicyclo [3.1.0]hexan-3-yl;  $\text{Y}_1$  is selected from CH and N;  $\text{Y}_2$  is selected from  $\text{CF}_2$ , O and  $\text{S}(\text{O})_{0.2}$ ;  $\text{Y}_3$  is selected from hydrogen, fluoro, chloro, methyl, difluoromethyl and trifluoromethyl; or the pharmaceutically acceptable salts thereof.

In a further embodiment are compounds selected from:

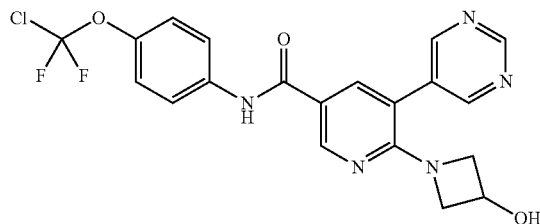
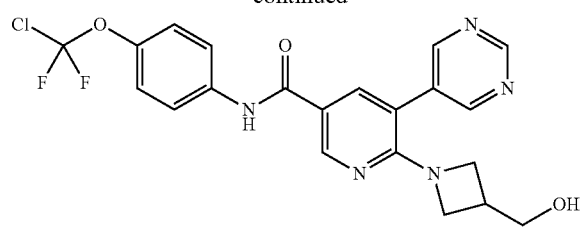


**41**

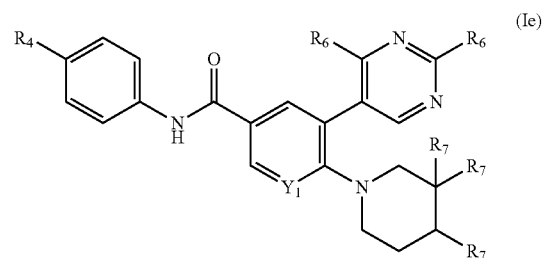
-continued

**42**

-continued

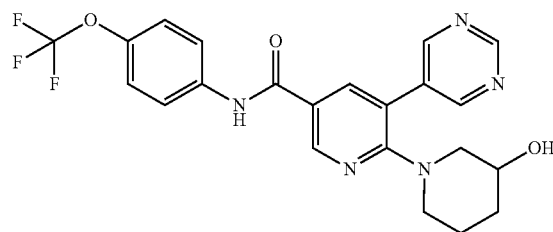


In another embodiment are compounds of formula (Ie):



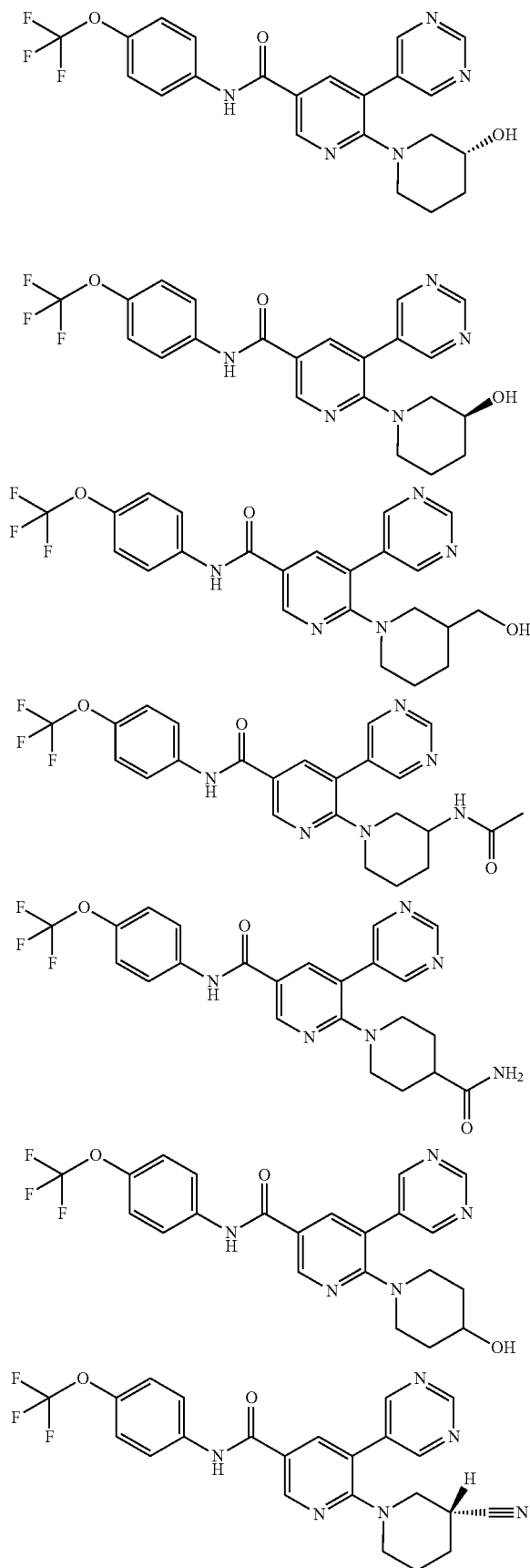
in which:  $R_4$  is selected from  $-\text{SF}_5$  and  $-\text{Y}_2-\text{CF}_2-\text{Y}_3$ ;  $R_6$  at each occurrence is independently selected from hydrogen, methyl, methoxy, methoxy-carbonyl, 2-hydroxypropan-2-yl, cyano, trifluoromethyl, hydroxy-methyl, halo, amino, fluoro-ethyl, ethyl and cyclopropyl;  $R_7$  at each occurrence is independently selected from hydroxy, methyl, methoxy, hydroxy-methyl, amino, methyl-amino, amino-methyl, trifluoromethyl, 2-hydroxypropan-2-yl, methyl-carbonyl-amino, dimethyl-amino, cyano and amino-carbonyl; or two  $R_7$  groups combine with the atom to which they are attached to form a ring selected from cyclopropyl and 3-azabicyclo [3.1.0]hexan-3-yl;  $\text{Y}_1$  is selected from CH and N;  $\text{Y}_2$  is selected from  $\text{CF}_2$ , O and  $\text{S}(\text{O})_{0-2}$ ;  $\text{Y}_3$  is selected from hydrogen, fluoro, chloro, methyl, difluoromethyl and trifluoromethyl; or the pharmaceutically acceptable salts thereof.

In a further embodiment are compounds selected from:

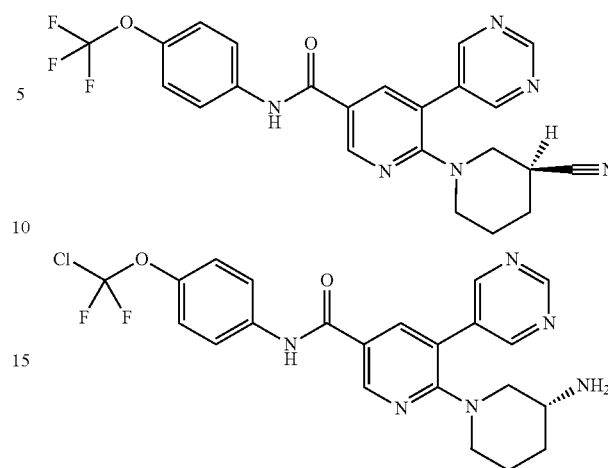


**43**

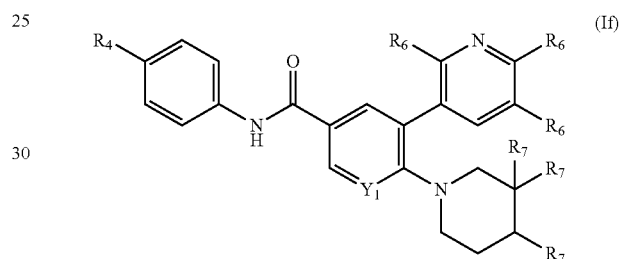
-continued

**44**

-continued

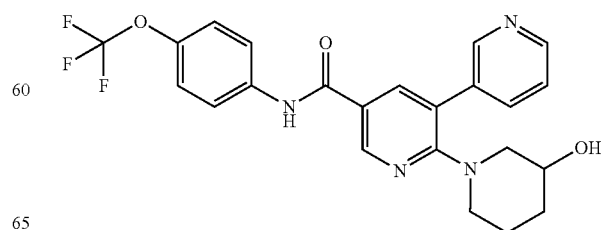


In another embodiment are compounds of formula (If):



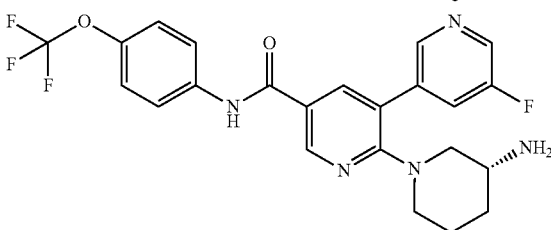
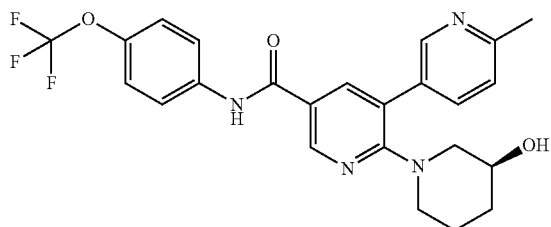
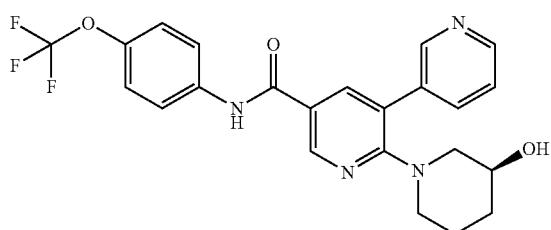
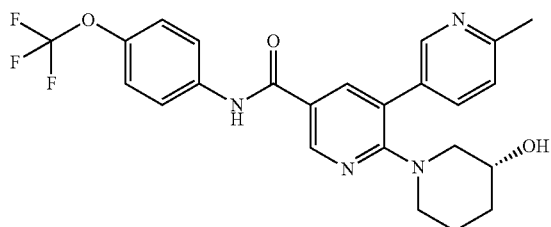
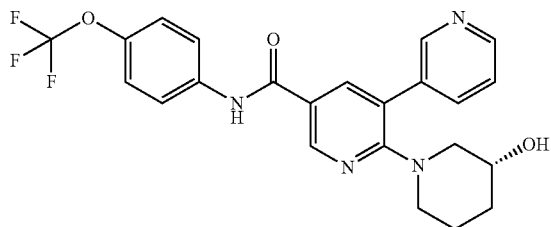
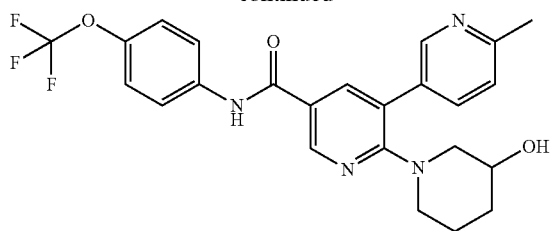
in which: R<sub>4</sub> is selected from —SF<sub>5</sub> and —Y<sub>2</sub>—CF<sub>2</sub>—Y<sub>3</sub>; R<sub>6</sub> at each occurrence is independently selected from hydrogen, methyl, methoxy, methoxy-carbonyl, 2-hydroxypropan-2-yl, cyano, trifluoromethyl, hydroxy-methyl, halo, amino, fluoro-ethyl, ethyl and cyclopropyl; R<sub>7</sub> at each occurrence is independently selected from hydroxy, methyl, methoxy, hydroxy-methyl, amino, methyl-amino, amino-methyl, trifluoromethyl, 2-hydroxypropan-2-yl, methyl-carbonyl-amino, dimethyl-amino, cyano and amino-carbonyl; or two R<sub>7</sub> groups combine with the atom to which they are attached to form a ring selected from cyclopropyl and 3-azabicyclo [3.1.0]hexan-3-yl; Y<sub>1</sub> is selected from CH and N; Y<sub>2</sub> is selected from CF<sub>2</sub>, O and S(O)<sub>0-2</sub>; Y<sub>3</sub> is selected from hydrogen, fluoro, chloro, methyl, difluoromethyl and trifluoromethyl; or the pharmaceutically acceptable salts thereof.

In a further embodiment are compounds selected from:

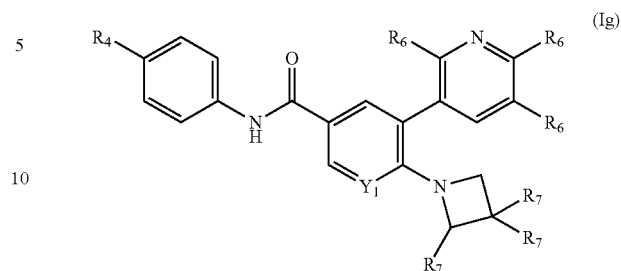


**45**

-continued

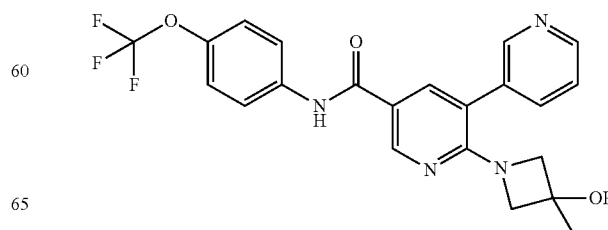
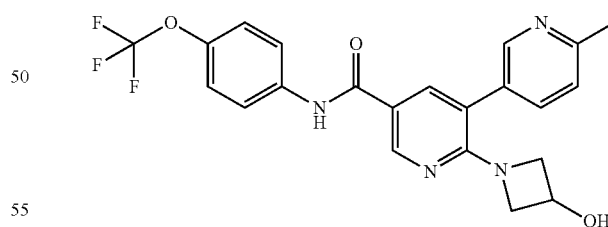
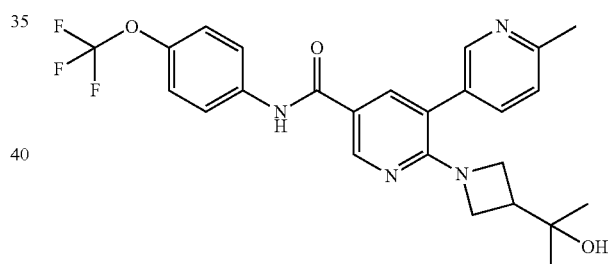
**46**

In another embodiment are compounds of formula (Ig):



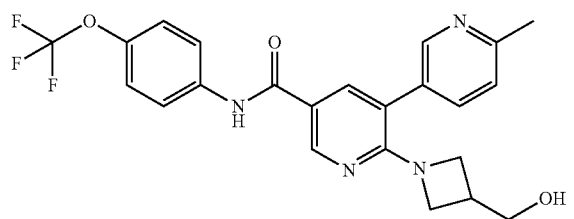
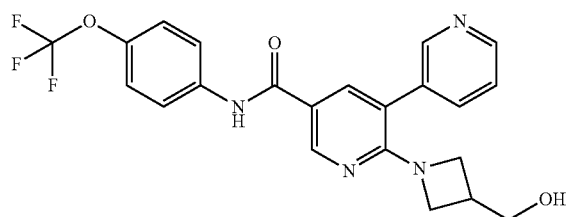
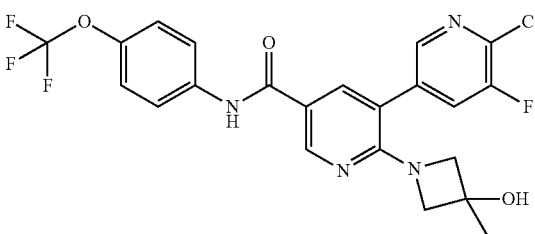
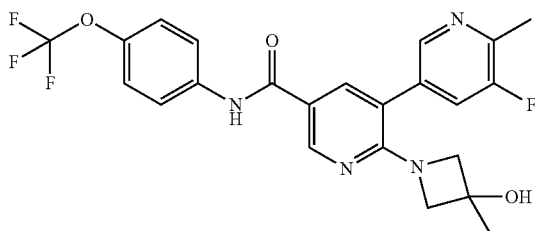
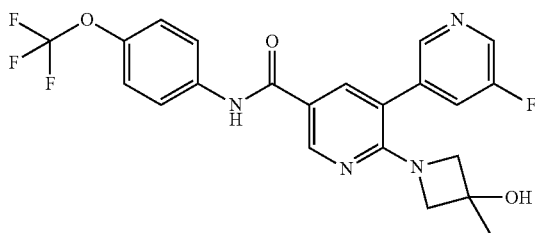
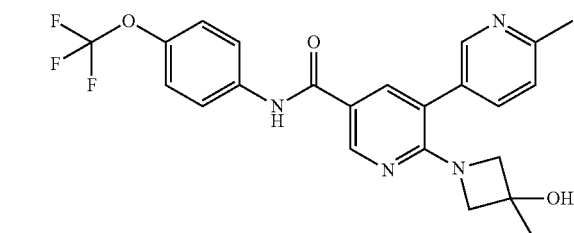
in which:  $R_4$  is selected from  $-\text{SF}_5$  and  $-\text{Y}_2-\text{CF}_2-\text{Y}_3$ ;  $R_6$  at each occurrence is independently selected from hydrogen, methyl, methoxy, methoxy-carbonyl, 2-hydroxypropan-2-yl, cyano, trifluoromethyl, hydroxy-methyl, halo, amino, fluoro-ethyl, ethyl and cyclopropyl;  $R_7$  at each occurrence is independently selected from hydroxy, methyl, methoxy, hydroxy-methyl, amino, methyl-amino, amino-methyl, trifluoromethyl, 2-hydroxypropan-2-yl, methyl-carbonyl-amino, dimethyl-amino, cyano and amino-carbonyl; or two  $R_7$  groups combine with the atom to which they are attached to form a ring selected from cyclopropyl and 3-azabicyclo [3.1.0]hexan-3-yl;  $\text{Y}_1$  is selected from CH and N;  $\text{Y}_2$  is selected from  $\text{CF}_2$ , O and  $\text{S}(\text{O})_{0.2}$ ;  $\text{Y}_3$  is selected from hydrogen, fluoro, chloro, methyl, difluoromethyl and trifluoromethyl; or the pharmaceutically acceptable salts thereof.

In a further embodiment are compounds selected from:

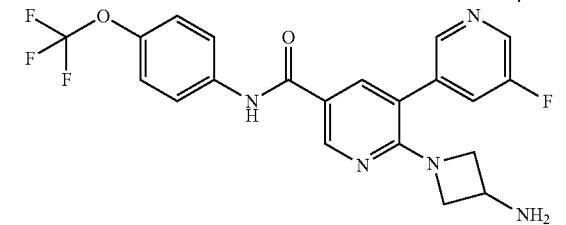
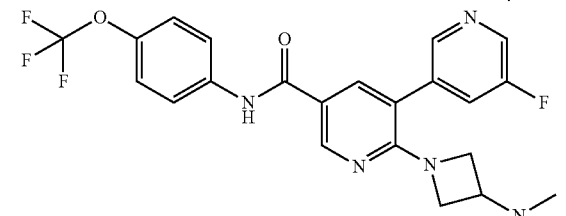
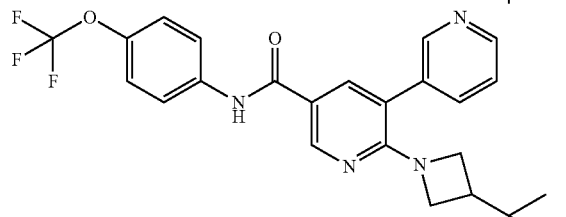
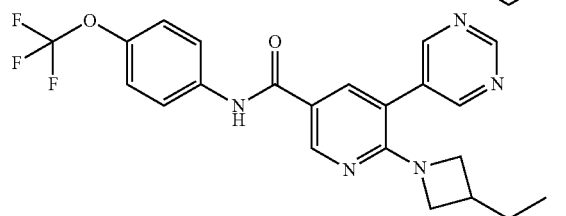
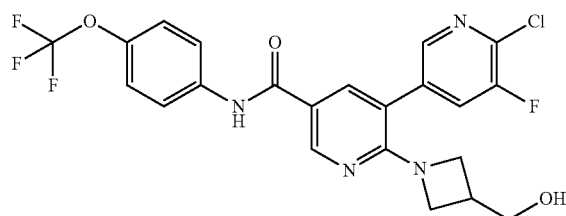
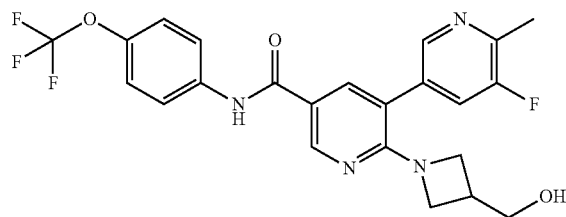
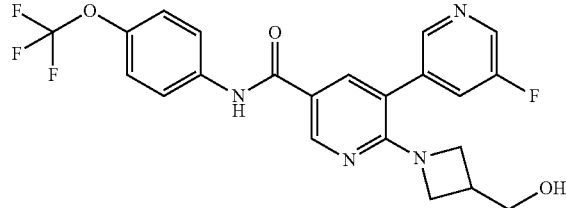


**47**

-continued

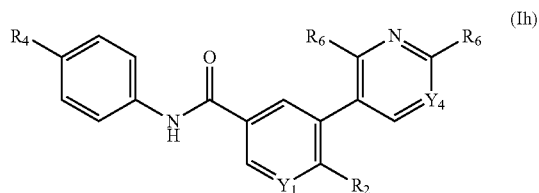
**48**

-continued



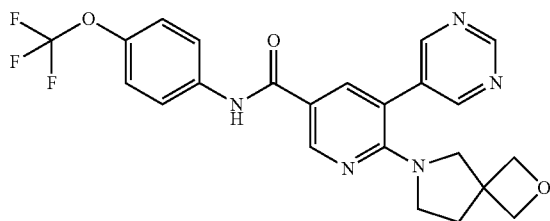
49

In another embodiment are compounds of formula (Ih):



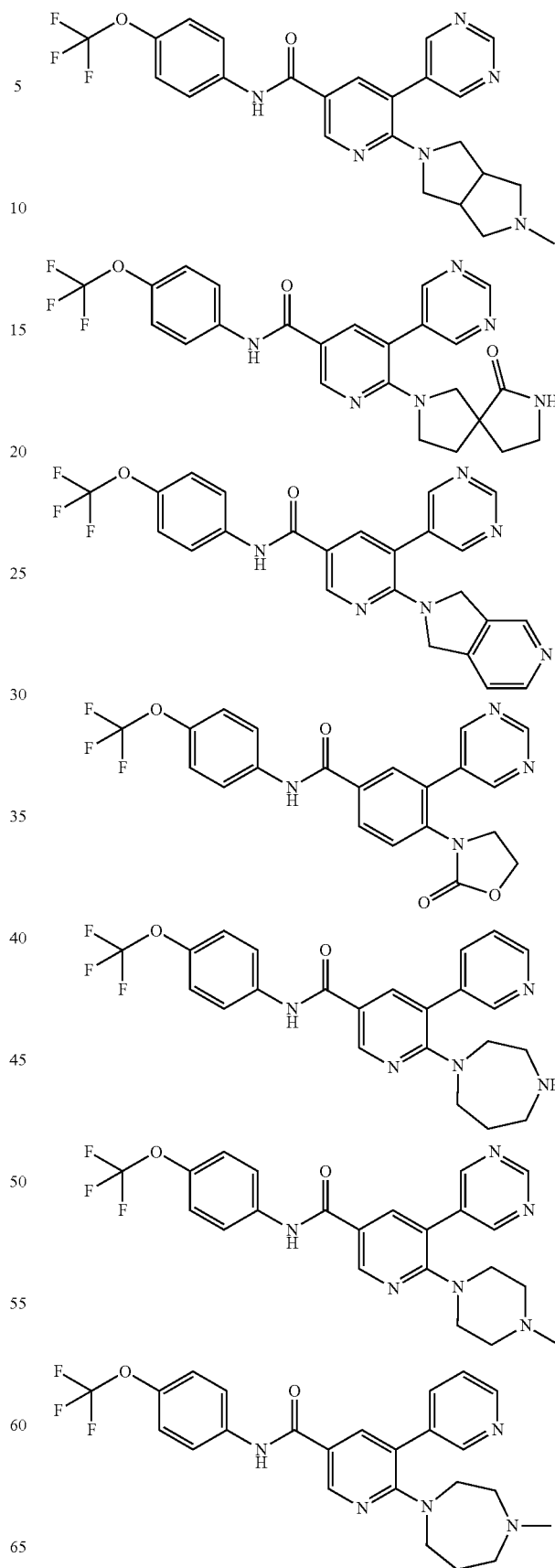
in which:  $R_2$  is selected from morpholino, piperazinyl, 2-oxa-6-azaspiro[3.4]-octanyl, hexahydropyrrolo[3,4-c]pyrrolyl, pyrrolo[3,4-c]pyrazol-5(1H,4H,6H)-yl, 6-oxo-2,7-diazaspiro[4.4]-nonanyl, 1H-pyrrolo[3,4-c]pyridinyl, 2-oxooxazolidinyl, 1,4-diazepanyl, 1,4-oxazepan-4-yl, tetrahydro-2H-pyranyl, 3,6-dihydro-2H-pyranyl, 3,8-dioxa-10-azabicyclo[4.3.1]decanyl,  $-OR_{5b}$  and  $-NR_{5a}R_{5b}$ ; wherein said morpholino, piperazinyl, 2-oxa-6-azaspiro[3.4]-octanyl, 1,4-oxazepan-4-yl, pyrrolo[3,4-c]pyrazol-5(1H,4H,6H)-yl, hexahydropyrrolo[3,4-c]pyrrolyl, 6-oxo-2,7-diazaspiro[4.4]-nonanyl, 1H-pyrrolo[3,4-c]pyridinyl, 2-oxooxazolidinyl, 1,4-diazepanyl, tetrahydro-2H-pyranyl, 3,6-dihydro-2H-pyranyl, or 3,8-dioxa-10-azabicyclo[4.3.1]decanyl is unsubstituted or substituted with 1 to 3  $R_7$  groups;  $R_4$  is selected from  $-SF_5$  and  $-Y_2-CF_2-Y_3$ ;  $R_{5a}$  is selected from hydrogen and methyl;  $R_{5b}$  is selected from ethyl, hydroxy-ethyl, hydroxy-propyl, dimethyl-amino-propyl and tetrahydro-2H-pyran-4-yl;  $R_6$  at each occurrence is independently selected from hydrogen, methyl, methoxy, cyano, trifluoromethyl, methoxy-carbonyl, 2-hydroxypropan-2-yl, hydroxy-methyl, halo, amino, fluoro-ethyl, ethyl and cyclopropyl;  $R_7$  at each occurrence is independently selected from hydroxy, methyl, methoxy, hydroxy-methyl, amino, methyl-amino, amino-methyl, trifluoromethyl, 2-hydroxypropan-2-yl, methyl-carbonyl-amino, dimethyl-amino, cyano and amino-carbonyl; or two  $R_7$  groups combine with the atom to which they are attached to form a ring selected from cyclopropyl and 3-azabicyclo[3.1.0]hexan-3-yl;  $Y_1$  is selected from CH and N;  $Y_2$  is selected from  $CF_2$ , O and  $S(O)_{0-2}$ ;  $Y_3$  is selected from hydrogen, fluoro, chloro, methyl, difluoromethyl and trifluoromethyl;  $Y_4$  is selected from  $CR_6$  and N; or the pharmaceutically acceptable salts thereof.

In a further embodiment are compounds selected from:



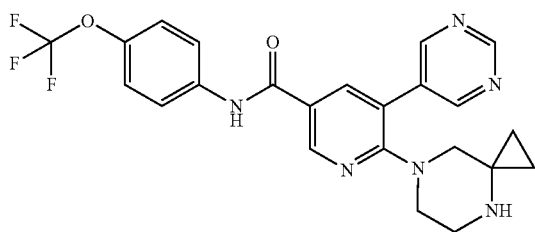
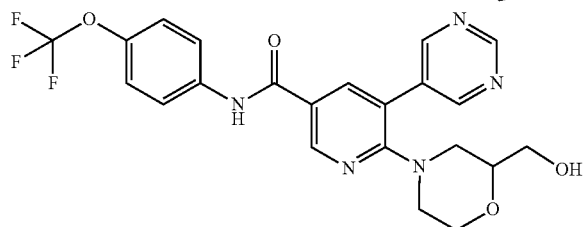
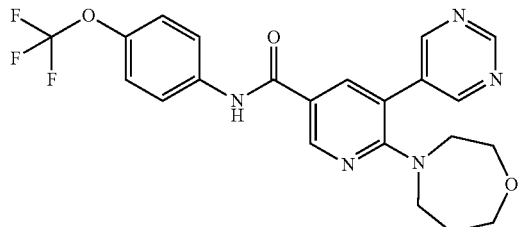
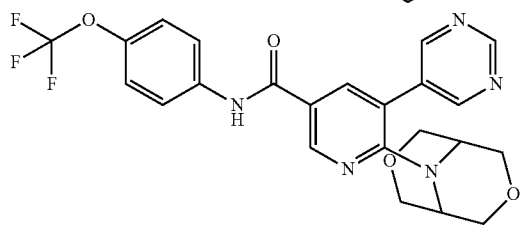
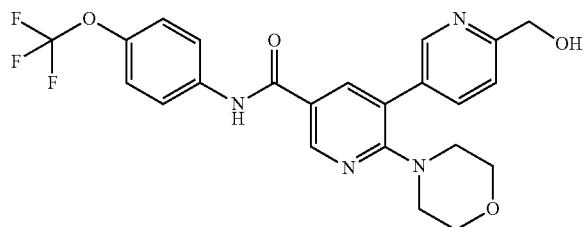
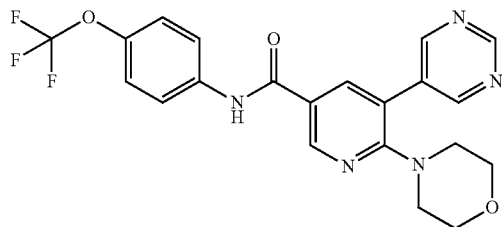
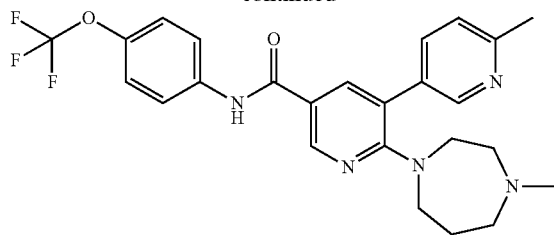
50

-continued

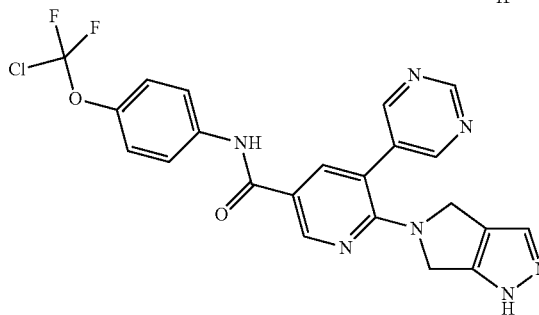
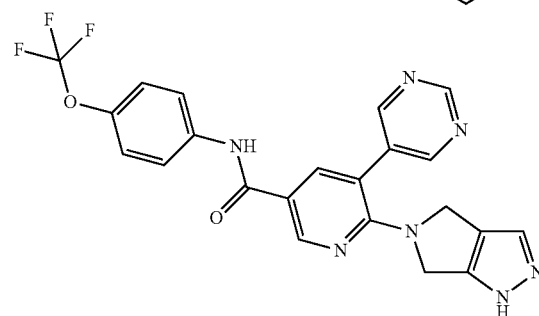
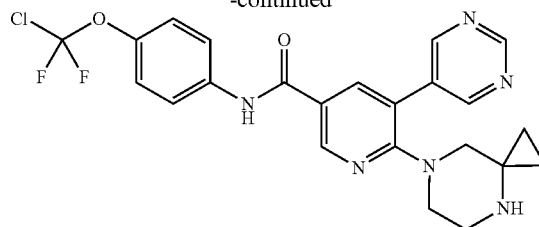


**51**

-continued

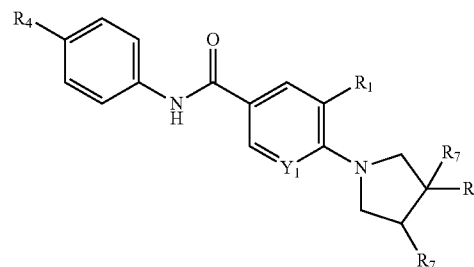
**52**

-continued



In another embodiment are compounds of formula (Ii):

(Ii)

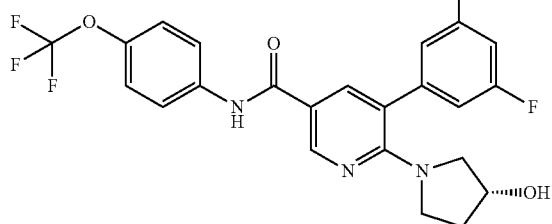
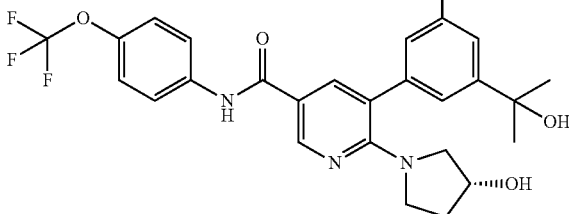
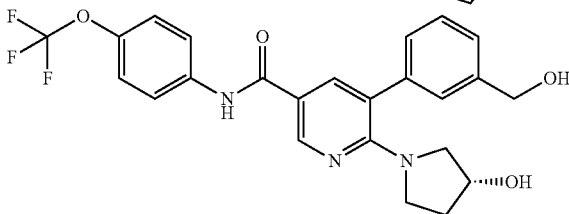
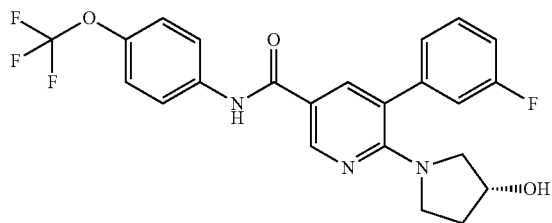
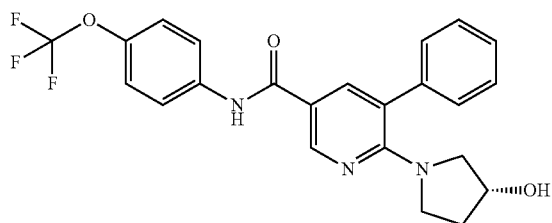
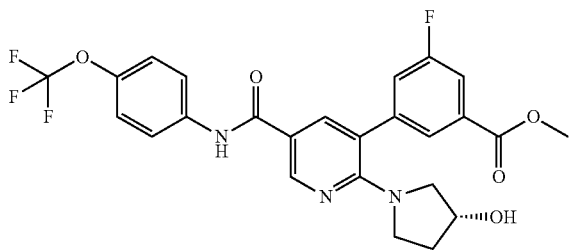


in which:  $R_1$  is selected from phenyl, quinoxaliny and isoquinoliny; wherein said phenyl, quinoxaliny or isoquinoliny of  $R_1$  is unsubstituted or substituted with 1 to 3  $R_6$  groups;  $R_4$  is selected from  $-SF_5$  and  $-Y_2-CF_2-Y_3$ ;  $R_6$  at each occurrence is independently selected from methyl, methoxy, cyano, trifluoromethyl, hydroxy-methyl, methoxy-carbonyl, 2-hydroxypropan-2-yl, halo, amino, fluoro-ethyl, ethyl and cyclopropyl;  $R_7$  at each occurrence is independently selected from hydroxy, methyl, methoxy, hydroxy-methyl, amino, methyl-amino, amino-methyl, trifluoromethyl, 2-hydroxypropan-2-yl, methyl-carbonyl-amino, dimethyl-amino, cyano and amino-carbonyl; or two  $R_7$  groups combine with the atom to which they are attached to form a ring selected from cyclopropyl and 3-azabicyclo[3.1.0]hexan-3-yl;  $Y_1$  is selected from CH and N;  $Y_2$  is selected from  $CF_2$ , O and

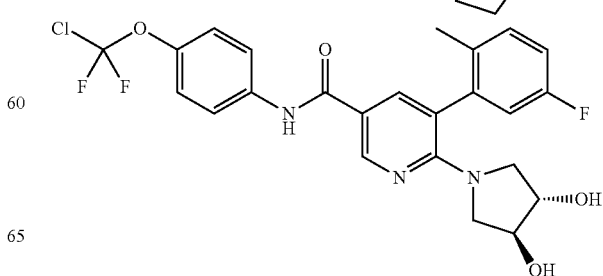
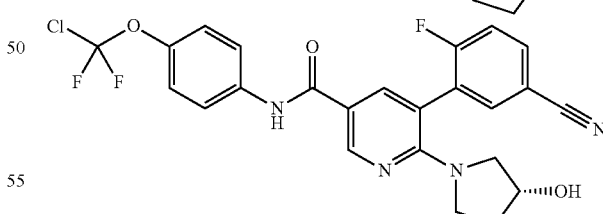
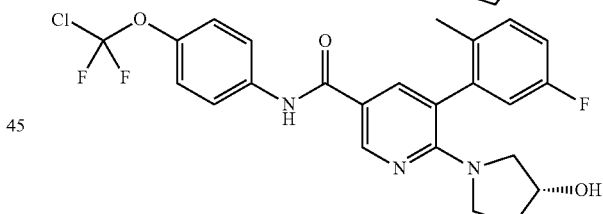
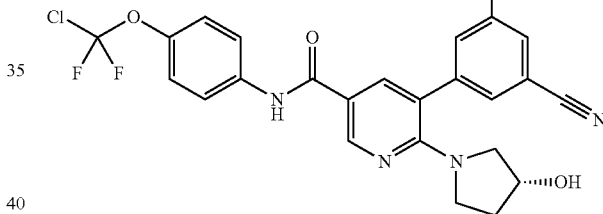
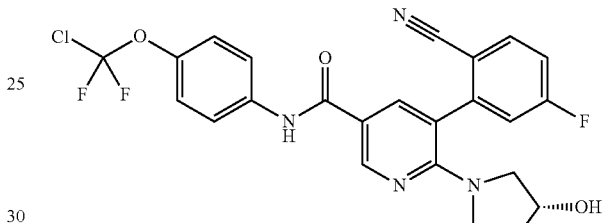
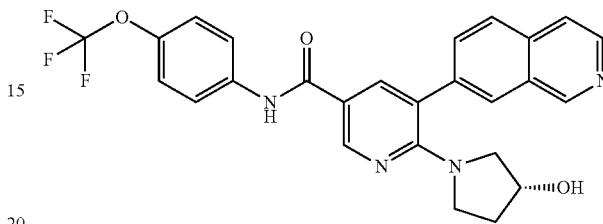
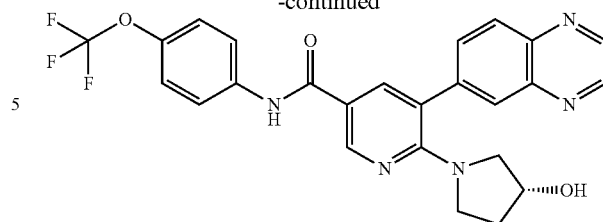
**53**

$S(O)_{0-2}; Y_3$  is selected from hydrogen, fluoro, chloro, methyl, difluoromethyl and trifluoromethyl; or the pharmaceutically acceptable salts thereof.

In a further embodiment are compounds selected from:

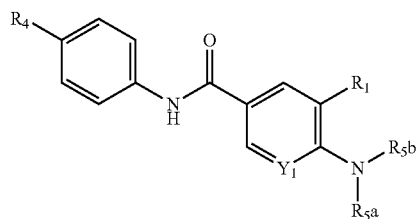
**54**

-continued



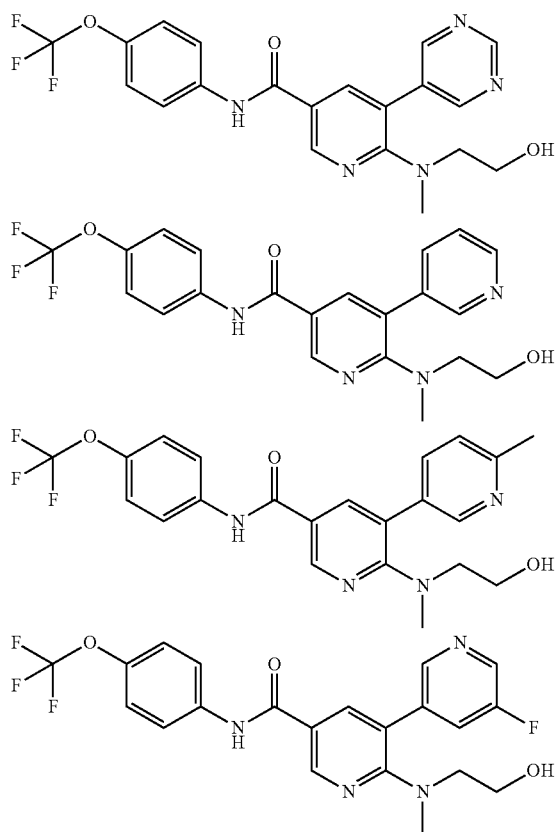
## 55

In another embodiment are compounds of formula (Ik):



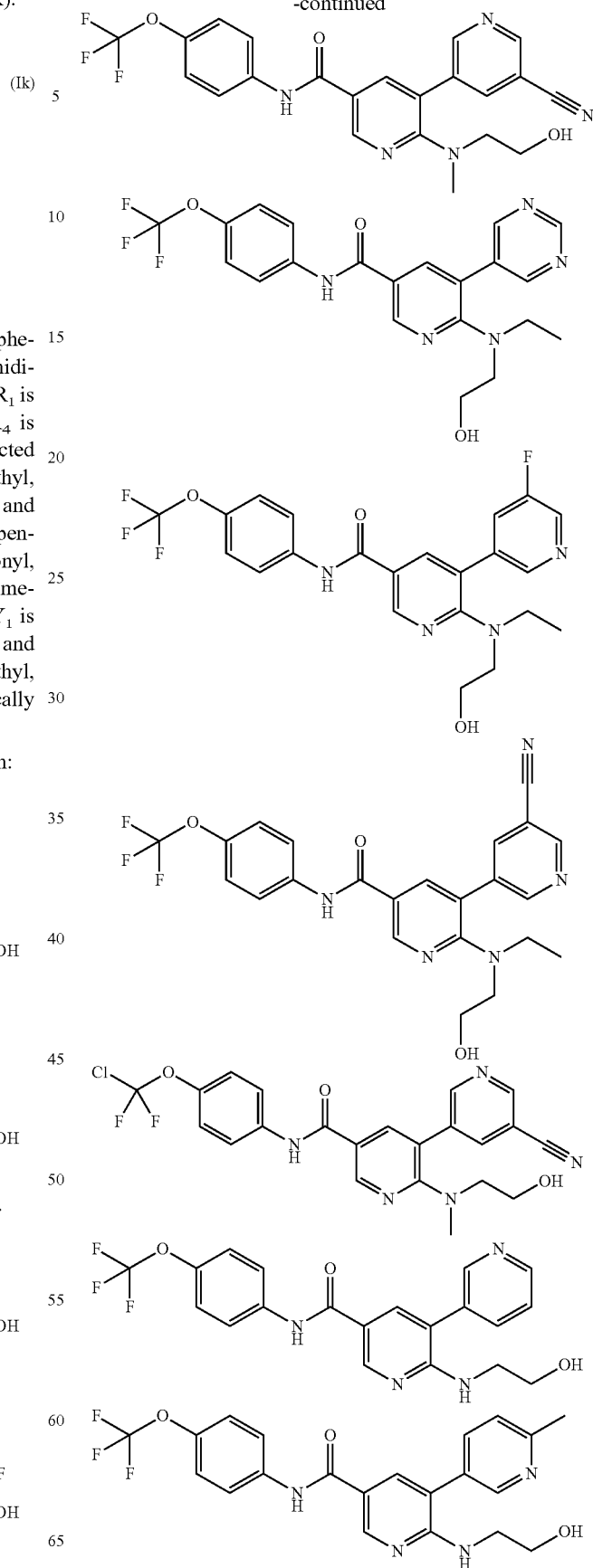
in which: R<sub>1</sub> is selected from pyrimidinyl, pyridinyl, phenyl, quinoxaliny and isoquinolinyl; wherein said pyrimidinyl, pyridinyl, phenyl, quinoxaliny and isoquinolinyl of R<sub>1</sub> is unsubstituted or substituted with 1 to 3 R<sub>6</sub> groups; R<sub>4</sub> is selected from —SF<sub>5</sub> and —Y<sub>2</sub>—CF<sub>2</sub>—Y<sub>3</sub>; R<sub>5<sub>a</sub></sub> is selected from hydrogen and methyl; R<sub>5<sub>b</sub></sub> is selected from ethyl, hydroxy-ethyl, hydroxy-propyl, dimethyl-amino-propyl and tetrahydro-2H-pyran-4-yl; R<sub>6</sub> at each occurrence is independently selected from methyl, methoxy, methoxy-carbonyl, 2-hydroxypropan-2-yl, cyano, trifluoromethyl, hydroxy-methyl, halo, amino, fluoro-ethyl, ethyl and cyclopropyl; Y<sub>1</sub> is selected from CH and N; Y<sub>2</sub> is selected from CF<sub>2</sub>, O and S(O)<sub>0-2</sub>; Y<sub>3</sub> is selected from hydrogen, fluoro, chloro, methyl, difluoromethyl and trifluoromethyl; or the pharmaceutically acceptable salts thereof.

In a further embodiment are compounds selected from:



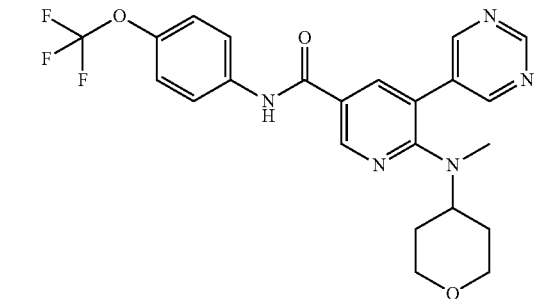
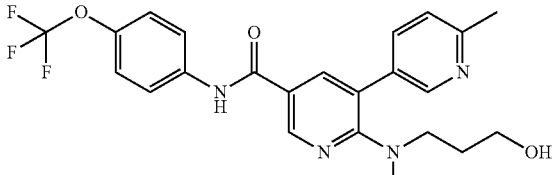
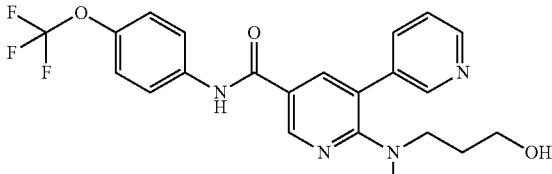
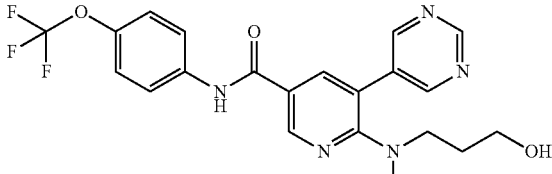
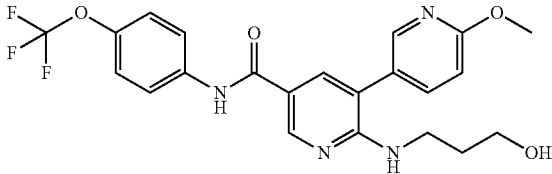
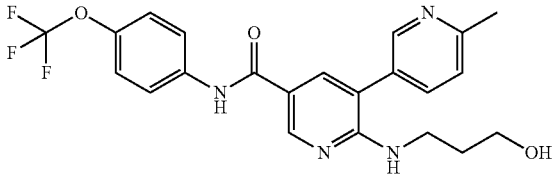
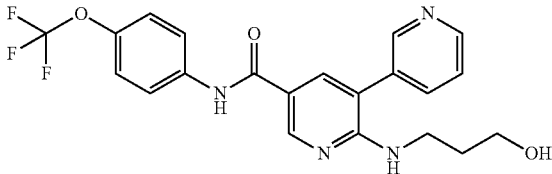
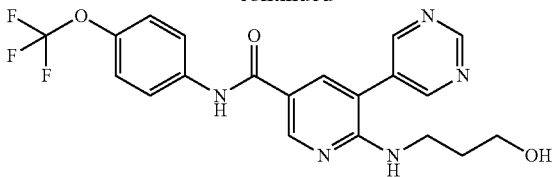
## 56

-continued



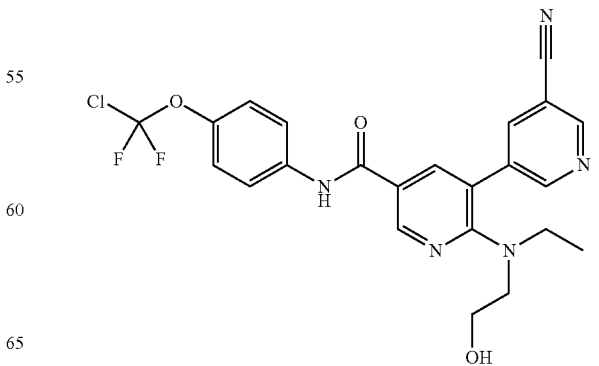
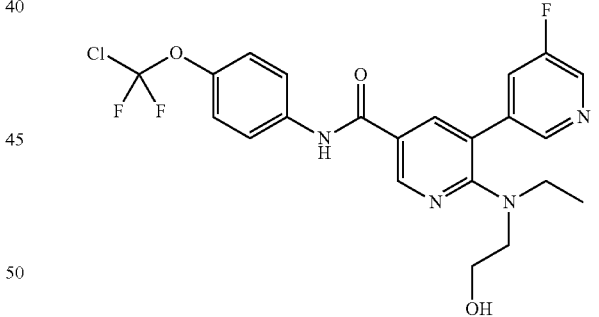
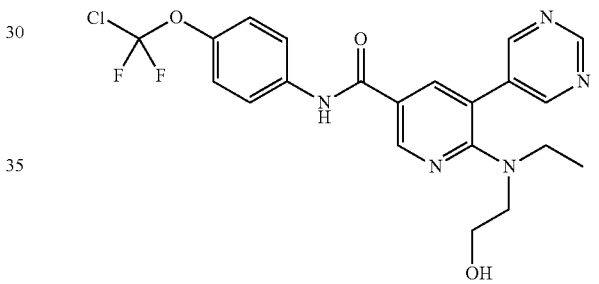
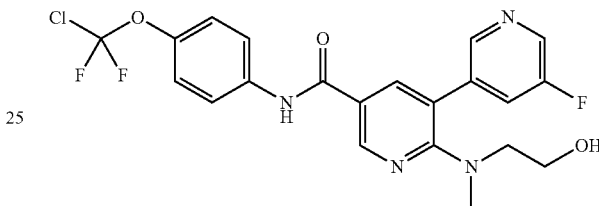
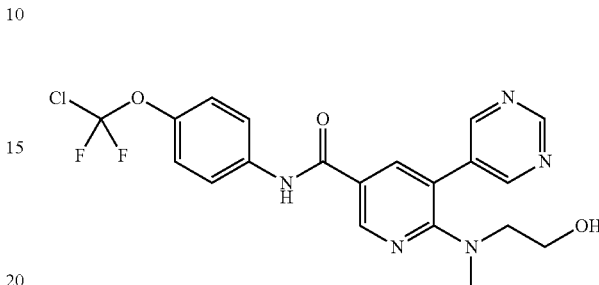
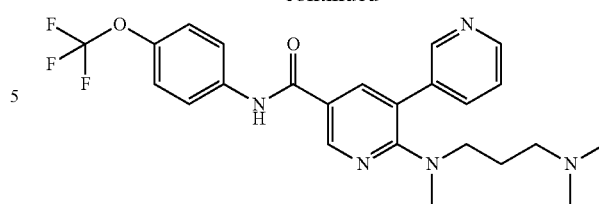
## 57

-continued



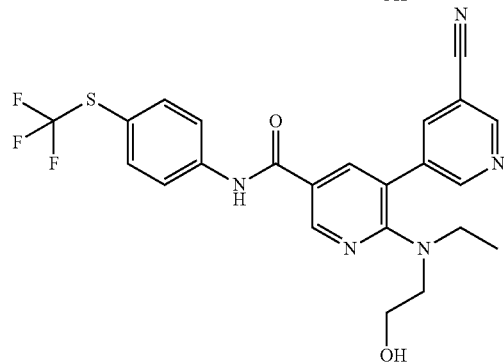
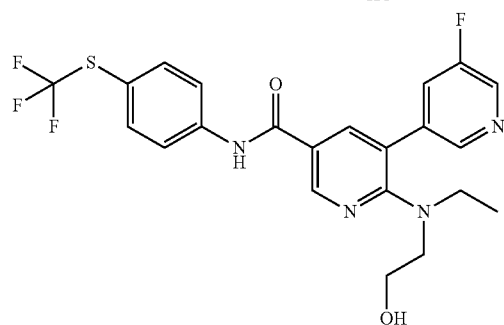
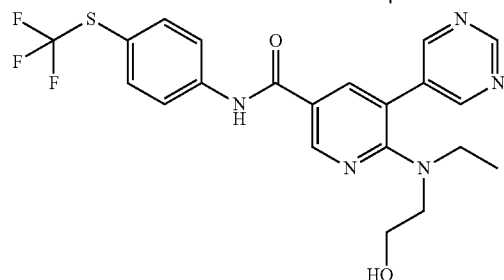
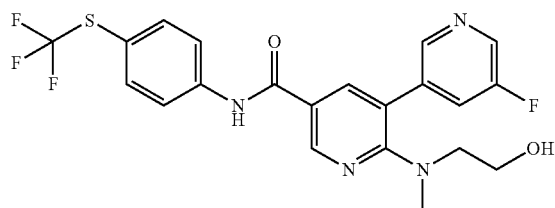
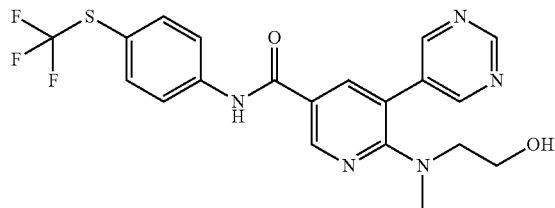
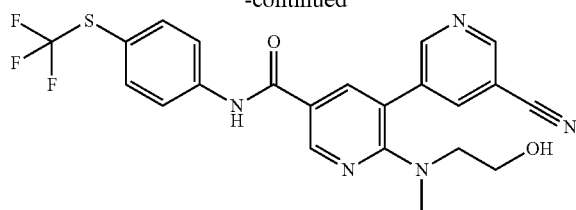
## 58

-continued



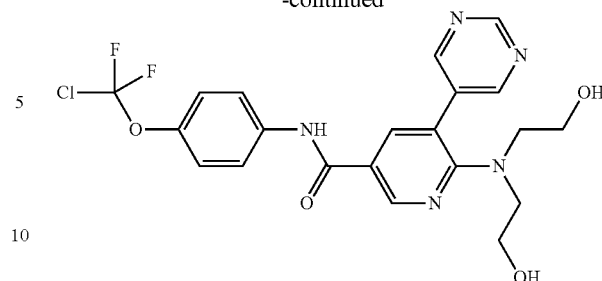
59

-continued



60

-continued



## Pharmacology and Utility

On the basis of the inhibitory studies described in the “Assay” section below, a compound of formula (I) according to the invention shows therapeutic efficacy especially against disorders dependent on BCR-ABL1 activity. In particular, compounds of the present invention inhibit the allosteric or myristoyl binding site of BCR-ABL1 (including wild-type BCR-ABL1 and/or mutations thereof).

Combining an ATP-competitive inhibitor of BCR-ABL1 with an allosteric inhibitor of BCR-ABL1 delays acquired resistance in BCR-ABL1+KCL-22 cells, in vitro. Surprisingly, BCR-ABL1+KCL-22 cells treated every 3-4 days with a compound of the invention showed an acquired resistance after approximately 28 days whereas these same cells treated every 3-4 days with nilotinib or dasatinib showed an acquired resistance after only 18-21 days. Even more surprisingly, when BCR-ABL1+KCL-22 cells were treated every 3-4 days with a combination of a compound of the invention and either nilotinib or dasatinib, no acquired resistance was observed in at least the first 60 days. Therefore, myristoyl-binding site compounds of the present invention, in combination with BCR-ABL1 inhibitors that bind to the ATP binding site are especially important for the treatment of proliferative diseases involving upregulation of ABL1 kinase activity, as in the case of BCR-ABL1 fusion proteins in CML and subsets of other haematological malignancies such as ALL and AML.

Carcinoma cells utilize invadopodia to degrade the extra cellular matrix during tumor invasion and metastasis. ABL kinase activity is required for Src-induced invadopodia formation, regulating distinct stages of invadopodia assembly and function. The compounds of the invention, therefore, as inhibitors of ABL, have the potential to be used as therapies for the treatment of metastatic invasive carcinomas.

An allosteric inhibitor of c-ABL kinase can be used to treat brain cancers: including Glioblastoma which is the most common & most aggressive malignant primary brain tumor in which the expression of c-ABL is immunohistochemically detectable in a subset of patients (Haberler C, Gelpi E, Marosi C, Rössler K, Birner P, Budka H, Hainfellner J A Immunohistochemical analysis of platelet-derived growth factor receptor-alpha, -beta, c-kit, c-abl, and arg proteins in glioblastoma: possible implications for patient selection for imatinib mesylate therapy. J Neurooncol. 2006 January; 76(2):105-9). However, clinical trials with Gleevec® failed in patients with glioblastoma (Reardon DA, Dresemann G, Taillibert S, Campone M, van den Bent M, Clement P, Blomquist E, Gordower L, Schultz H, Raizer J, Hau P, Easaw J, Gil M, Tonn J, Gijtenbeek A, Schlegel U, Bergstrom P, Green S, Weir A, Nikolova Z. Multicentre phase II studies evaluating imatinib

61

plus hydroxyurea in patients with progressive glioblastoma. *Br J Cancer*. 2009 Dec. 15; 101(12):1995-2004; Razis E, Selvaridis P, Labropoulos S, Norris J L, Zhu M J, Song D D, Kalebic T, Torrens M, Kalogera-Fountzila A, Karkavelas G, Karanastasi S, Fletcher J A, Fountzilas G. Phase II study of neoadjuvant imatinib in glioblastoma: evaluation of clinical and molecular effects of the treatment. *Clin Cancer Res*. 2009 Oct. 1; 15(19):6258-66; Dresemann G. Imatinib and hydroxyurea in pretreated progressive glioblastoma multiforme: a patient series. *Ann Oncol*. 2005 October; 16(10):1702-8), possibly because of the poor brain intratumoral exposure of the drug and in the absence of disturbed blood-brain barrier (Holdhoff et al, *J Neurooncol*. 2010; 97(2):241-5). The transport of Gleevec® across the blood-brain barrier is in fact shown in preclinical studies to be limited by active efflux transporters such as P-glycoprotein. This is also the case for Dasatinib (Chen Y, Agarwal S, Shaik N M, Chen C, Yang Z, Elmquist W F. P-glycoprotein and breast cancer resistance protein influence brain distribution of dasatinib. *J Pharmacol Exp Ther*. 2009 September; 330(3):956-63). Irradiation is known to enhance the blood-brain barrier opening. In mouse models, glioblastoma multiforme response to Gleevec® correlated with an increase in tumor growth delay and survival when Gleevec® was administered in conjunction with daily irradiation (Geng L, Shinohara E T, Kim D, Tan J, Osusky K, Shyr Y, Hallahan D E. STI571 (Gleevec) improves tumor growth delay and survival in irradiated mouse models of glioblastoma. *Int J Radiat Oncol Biol Phys*. 2006 Jan. 1; 64(1):263-71). Therefore a new c-Abl inhibitor with high brain exposure represents a solid therapeutic approach for glioblastoma and other brain cancers.

CNS-CML: In some CML patients treated with Gleevec®, CNS Blast crisis and failure have been reported and can be explained by the poor brain exposure of Gleevec®. (Kim H J, Jung C W, Kim K, Ahn J S, Kim W S, Park K, Ko Y H, Kang W K, Park K. Isolated blast crisis in CNS in a patient with chronic myelogenous leukemia maintaining major cytogenetic response after imatinib. *J Clin Oncol*. 2006 Aug. 20; 24(24):4028-9; Radhika N, Minakshi M, Rajesh M, Manas B R, Deepak Kumar M. Central nervous system blast crisis in chronic myeloid leukemia on imatinib mesylate therapy: report of two cases. *Indian J Hematol Blood Transfus*. 2011 March; 27(1):51-4). In fact, in CML patients, Gleevec®'s concentration is in fact much lower (~100 fold) in the CNS than in plasma (Leis J F, Stepan D E, Curtin P T, Ford J M, Peng B, Schubach S, Druker B J, Maziarz R T. Central nervous system failure in patients with chronic myelogenous leukemia lymphoid blast crisis and Philadelphia chromosome positive acute lymphoblastic leukemia treated with imatinib (STI-571). *Leuk Lymphoma*. 2004 April; 45(4):695-8). Therefore, c-ABL inhibitors from the present invention which show a high brain exposure represent a valid approach for development of therapies against CML including CNS-CML.

Compounds of the invention can be useful in the treatment of viruses. For example, viral infections can be mediated by ABL1 kinase activity, as in the case of pox-viruses and the Ebola virus. Gleevec® and Tasigna® have been shown to stop the release of Ebola viral particles from infected cells, in vitro (Kalman, Daniel; Bornmann, William Gerard, Methods of use of non-ATP competitive tyrosine kinase inhibitors to treat

62

pathogenic infection, PCT Int. Appl. 2007, WO 2007002441; Garcia Mayra; Cooper Arik; Shi Wei; Bornmann William; Carrion Ricardo; Kalman Daniel; Nabel Gary J. Productive Replication of Ebola Virus Is Regulated by the c-ABL1 Tyrosine Kinase. *Science translational medicine* 2012; 4:123ra24). Compounds of the present invention that inhibit c-ABL kinase, therefore, can be expected to reduce the pathogen's ability to replicate.

Compounds of the invention can also be useful in the treatment of neural degeneration. While native c-ABL tyrosine kinase remains relatively quiescent in healthy adult brain, it can be activated in the brain of patients with CNS diseases, including neurodegenerative diseases such as, Alzheimer's disease (AD), Parkinson's disease (AD), frontotemporal dementia (FTD), Picks disease, Niemann-Pick type C disease (NPC) and other degenerative, inflammatory and autoimmune diseases and ageing.

Parkinson's disease is the second most prevalent chronic neurodegenerative disease with the most common familial autosomal-recessive form being caused by mutations in the E3 ubiquitin ligase, parkin. Recent studies showed that activated c-ABL was found in the striatum of patients with sporadic Parkinson's disease. Concomitantly, parkin was tyrosine-phosphorylated, causing loss of its ubiquitin ligase and cytoprotective activities as indicated by the accumulation of parkin substrates (Ko H S, Lee Y, Shin J H, Karuppagounder S S, Gadad B S, Koleske A J, Pletnikova O, Troncoso J C, Dawson V L, Dawson T M. Phosphorylation by the c-Abl protein tyrosine kinase inhibits parkin's ubiquitination and protective function. *Proc Natl Acad Sci USA*. 2010 Sep. 21; 107(38):16691-6; Imam S Z, Zhou Q, Yamamoto A, Valente A J, Ali S F, Bains M, Roberts J L, Kahle P J, Clark R A, Li S. Novel regulation of parkin function through c-Abl-mediated tyrosine phosphorylation: implications for Parkinson's disease. *J Neurosci*. 2011 Jan. 5; 31(1):157-63). These two studies also showed that in cell or animal models of Parkinson's disease, pharmacological inhibition of c-ABL kinase or genetic ABL knockdown prevented tyrosine phosphorylation of parkin and restored its E3 ligase activity and cytoprotective function both in vitro and in vivo. These results indicate that c-ABL-dependent tyrosine phosphorylation of parkin is a major post-translational modification that leads to loss of parkin function and disease progression in sporadic PD. Therefore, the ability of compounds of the invention to inhibit the myristate-binding site of ABL1, can be expected to offer new therapeutic opportunities for blocking the progression of Parkinson's disease.

Alzheimer's disease is characterized by two main hallmarks: extracellular deposits of the neurotoxic amyloid- $\beta$  which leads to amyloid plaque development, and intracellular accumulation of hyperphosphorylated tau which contributes to the development of neurofibrillary tangles (NFTs).

Amyloid- $\beta$  level is reduced following intrathecal treatment with Gleevec® in the brain of wild-type guinea-pigs and in cell models (Netzer W J, Dou F, Cai D, Veach D, Jean S, Li Y, Bornmann W G, Clarkson B, Xu H, Greengard P. Gleevec inhibits beta-amyloid production but not Notch cleavage. *Proc Natl Acad Sci USA*. 2003 Oct. 14; 100(21):12444-9). The same group proposed that Gleevec® achieves its amyloid- $\beta$ -lowering effect via a new mechanism preventing GSAP interaction with the gamma-secretase substrate, APP-

CTF (He G, Luo W, Li P, Remmers C, Netzer W J, Hendrick J, Bettayeb K, Flajolet M, Gorelick F, Wennogle L P, Green-gard P. Gamma-secretase activating protein is a therapeutic target for Alzheimer's disease. *Nature*. 2010 Sep. 2; 467 (7311):95-8). In this study, Gleevec®'s effect to inhibit GSAP/APP-CTF was only seen at micromolar concentrations. Another group showed that tyrosine phosphorylation of the intracellular domain of APP (i.e. Tyr682) regulates the amyloidogenic APP processing accelerating amyloid- $\beta$  formation in vivo (Barbagallo A P, Weldon R, Tamayev R, Zhou D, Giliberto L, Foreman O, D'Adamio L. Tyr(682) in the intracellular domain of APP regulates amyloidogenic APP processing in vivo. *PLoS One*. 2010 Nov. 16; 5(11):e15503). Other studies showed that APP is tyrosine-phosphorylated in cells expressing a constitutively active form of the ABL oncogene (Zambrano N, Bruni P, Minopoli G, Mosca R, Molino D, Russo C, Schettini G, Sudol M, Russo T. The beta-amyloid precursor protein APP is tyrosine-phosphorylated in cells expressing a constitutively active form of the Abl proto-oncogene. *J Biol Chem*. 2001 Jun. 8; 276(23):19787-92). These data together suggest a c-ABL-dependent amyloidogenic APP processing for the formation of the toxic amyloid- $\beta$  peptide and subsequent amyloid plaques. Therefore a c-ABL inhibitor would be expected to lower amyloid plaque formation in Alzheimer's patients.

Tau has been shown to be phosphorylated by c-Abl kinase at tyrosines 18, 197, 310, and 394 in cell models, and tau pY394 has been shown to be present in the lesions NFTs in the brain of AD patients.

c-ABL is activated in the brain of patients with sporadic Alzheimer's disease as shown by its phosphorylation either at Y412, an indicator of activation, which co-localizes granulo-vacuolar degeneration, or at T735 which co-localized with the typical lesions, amyloid plaques, neurofibrillary tangles (NFTs) in addition to GVD. Amyloid- $\beta$  and oxidative stress activate c. ABL kinase in neuronal cultures and intracerebral injection of fibrillar amyloid peptide leads to increased expression of c-ABL and a downstream effector p73. Transgenic mice (APP/Swe mouse model of AD), showed higher levels of c-ABL in their brain and, when these mice were treated with the c-ABL inhibitor Gleevec®, tau phosphorylation was decreased in their brains. A transgenic mouse model expressing constitutively active c-ABL in forebrain neurons exhibited neuronal loss, severe neuroinflammation, and tyrosine phosphorylation of tau in the brain (For review, see Schlatterer S D, Acker C M, Davies P. c-Abl in neurodegenerative disease. *J Mol Neurosci*. 2011 November; 45(3): 445-52).

Based on all these results, evidence exists for a role for c-ABL kinase in Alzheimer's pathogenesis for development of both lesions, amyloid plaques and neurofibrillary tangles.

Further, activated c-ABL is also present in other tauopathies besides sporadic Alzheimer's including in the brain of patients with frontotemporal dementia with N279K and P301L mutations, Pick's disease, and Guam Parkinson-dementia (Schlatterer S D, Acker C M, Davies P. c-Abl in neurodegenerative disease. *J Mol Neurosci*. 2011 November; 45(3):445-52).

Therefore, compounds of the present invention, by inhibiting c-ABL in the CNS, represent a valid approach for development of therapies against Alzheimer's disease, as well as

other  $\beta$ -amyloidoses, such as vascular dementia and other tauopathies, such as frontotemporal dementia and picks disease.

Niemann-Pick type C (NPC) disease is a fatal autosomal recessive disorder characterized by the accumulation of free cholesterol and glycosphingolipids in the endosomal-lysosomal system, and by a progressive neuronal death in particular of cerebellar Purkinje neurons. In a mouse model of NPC, the proapoptotic c-ABL, the downstream target as well as p73 target genes are expressed in the cerebellums. Inhibition of c-ABL with Gleevec® prevented from loss of Purkinje neurons, improved neurological symptoms, and increased the survival. This prosurvival effect of Gleevec® correlated with reduced mRNA levels of p73 proapoptotic target genes (Alvarez A R, Klein A, Castro J, Cancino G I, Amigo J, Mosqueira M, Vargas L M, Yévenes L F, Bronfman F C, Zanlungo S. Imatinib therapy blocks cerebellar apoptosis and improves neurological symptoms in a mouse model of Niemann-Pick type C disease. *FASEB J*. 2008 October; 22(10):3617-27). Therefore, compounds of the present invention, by inhibiting c-ABL kinase, represent a valid approach for the development of therapies against diseases caused by the proapoptotic c-ABL/p73 pathway, such as NPC.

In prion disease models, Gleevec® showed beneficial effects: It delayed prion neuroinvasion by inhibiting prion propagation from the periphery to the CNS (Yun S W, Ertmer A, Flechsig E, Gilch S, Riederer P, Gerlach M, Schätzl H M, Klein M A. The tyrosine kinase inhibitor imatinib mesylate delays prion neuroinvasion by inhibiting prion propagation in the periphery. *J Neurovirol*. 2007 August; 13(4):328-37). Gleevec® and ABL deficiency induced cellular clearance of PrPSc in prion-infected cells (Ertmer A, Gilch S, Yun S W, Flechsig E, Klebl B, Stein-Gerlach M, Klein M A, Schätzl H M. The tyrosine kinase inhibitor STI571 induces cellular clearance of PrPSc in prion-infected cells. *J Biol Chem*. 2004 Oct. 1; 279(40):41918-27). Therefore, novel c-Abl inhibitors from the present invention also represent a valid therapeutic approach for the treatment of prion diseases such as Creutzfeldt-Jacob disease.

X-linked recessive Emery-Dreifuss muscular dystrophy is caused by mutations of emerin, a nuclear-membrane protein with roles in nuclear architecture, gene regulation and signaling. A recent study has shown that emerin is tyrosine-phosphorylated directly by c-ABL in cell models, and that the phosphorylation status of emerin changes emerin binding to other proteins such as BAF. This, in turn, may explain the mislocalization of mutant emerin from nuclear to cytosolic compartments and consequently changes in downstream effector and signal integrator for signaling pathway(s) at the nuclear envelope (Tift K E, Bradbury K A, Wilson K L. Tyrosine phosphorylation of nuclear-membrane protein emerin by Src, Abl and other kinases. *J Cell Sci*. 2009 Oct. 15; 122(Pt 20):3780-90). Changes in emerin-lamin interactions during both mitosis and interphase are of relevance for the pathology of muscular dystrophies. In addition, results from another study demonstrate that Gleevec® attenuates skeletal muscle dystrophy in mdx mice (Huang P, Zhao X S, Fields M, Ransohoff R M, Zhou L. Imatinib attenuates skeletal muscle dystrophy in mdx mice. *FASEB J*. 2009 August; 23(8):2539-48).

Therefore, novel c-ABL inhibitors from the present invention also represent therapeutic approaches for treatment of skeletal and muscular dystrophies.

Furthermore, c-ABL kinase plays a role in inflammation and oxidative stress, two mechanisms that are implicated in a variety of human diseases ranging from acute CNS diseases, such as stroke and traumatic brain or spinal cord injuries, chronic CNS diseases, such as Alzheimer's, Parkinson's, Huntington's and motoneuron diseases, to non-CNS inflammatory and autoimmune diseases, such as diabetes, pulmonary fibrosis.

For example, Gleevec® prevents fibrosis in different pre-clinical models of systemic sclerosis and induces regression of established fibrosis (Akhmetshina A, Venalis P, Dees C, Busch N, Zwerina J, Schett G, Distler O, Distler J H. Treatment with imatinib prevents fibrosis in different preclinical models of systemic sclerosis and induces regression of established fibrosis. *Arthritis Rheum.* 2009 January; 60(1):219-24) and it shows antifibrotic effects in bleomycin-induced pulmonary fibrosis in mice (Aono Y, Nishioka Y, Inayama M, Ugai M, Kishi J, Uehara H, Izumi K, Sone S. Imatinib as a novel antifibrotic agent in bleomycin-induced pulmonary fibrosis in mice. *Am J Respir Crit Care Med.* 2005 Jun. 1; 171(11):1279-85). Another study showed that both imatinib and nilotinib attenuated bleomycin-induced acute lung injury and pulmonary fibrosis in mice (Rhee C K, Lee S H, Yoon H K, Kim S C, Lee S Y, Kwon S S, Kim Y K, Kim K H, Kim T J, Kim J W. Effect of nilotinib on bleomycin-induced acute lung injury and pulmonary fibrosis in mice. *Respiration.* 2011; 82(3):273-87). Although in these studies the authors were focusing on the implication of the mechanism related to PDGFRs, of interest, in the study by Rhee et al. (*Respiration.* 2011; 82(3):273-87), nilotinib which is a more potent c-ABL inhibitor than imatinib showed superior therapeutic antifibrotic effects, thus supporting the therapeutic applicability of c-ABL inhibitors for treatment of human diseases with pulmonary inflammation. In another study, exposure of mice to hyperoxia increased c-Abl activation which is required for dynamin 2 phosphorylation and reactive oxygen species production and pulmonary leak (Singleton P A, Pendyala S, Gorshkova I A, Mambetsariev N, Moitra J, Garcia J G, Narayanan V. Dynamin 2 and c-Abl are novel regulators of hyperoxia-mediated NADPH oxidase activation and reactive oxygen species production in caveolin-enriched microdomains of the endothelium. *J Biol Chem.* 2009 Dec. 11; 284(50):34964-75).

Therefore, these data indicate that new c-ABL inhibitors from the present invention have therapeutic applicability for treatment of human diseases with pulmonary inflammation.

c-ABL activation by insulin, via a modification of FAK response, may play an important role in directing mitogenic versus metabolic insulin receptor signaling (Genua M, Pandini G, Cassarino M F, Messina R L, Frasca F. c-Abl and insulin receptor signalling. *Vitam Horm.* 2009; 80:77-105). c-Abl inhibitors such as Gleevec® have been shown to reverse type 1 diabetes in nonobese diabetic mice (Louvét C, Szot G L, Lang J, Lee M R, Martinier N, Bollag G, Zhu S, Weiss A, Bluestone J A. Tyrosine kinase inhibitors reverse type 1 diabetes in nonobese diabetic mice. *Proc Natl Acad Sci USA.* 2008 Dec. 2; 105(48):18895-900). Amelioration of diabetes by Gleevec® was mimicked by siRNA-mediated

knockdown of c-ABL mRNA (Hägerkvist R, Sandler S, Mokhtari D, Welsh N. Amelioration of diabetes by imatinib mesylate (Gleevec): role of beta-cell NF-kappaB activation and anti-apoptotic preconditioning. *FASEB J.* 2007 February; 21(2):618-28).

Therefore, the new c-ABL inhibitors from the present invention have therapeutic applicability for treatment of human diabetes.

A c-ABL inhibitor from the present invention can be used in combination with one or more of the existing treatment for the above diseases: for example a c-ABL inhibitor from the present invention can be used in combination with Levodopa or other L-DOPA-containing medicaments or a dopamine agonist for the treatment of Parkinson's disease or in combination with a cholinesterase inhibitor such as Exelon capsule or transdermal patch for the treatment of Alzheimer's disease.

In chronic myelogenous leukemia (CML), a reciprocal balanced chromosomal translocation in hematopoietic stem cells (HSCs) produces the BCR-ABL1 hybrid gene. The latter encodes the oncogenic BCR-ABL1 fusion protein. Whereas ABL encodes a tightly regulated protein tyrosine kinase, which plays a fundamental role in regulating cell proliferation, adherence and apoptosis, the BCR-ABL1 fusion gene encodes as constitutively activated kinase. This activated kinase transforms HSCs to produce a phenotype exhibiting deregulated clonal proliferation, reduced capacity to adhere to the bone marrow stroma and a reduced apoptotic response to mutagenic stimuli, resulting in progressively more malignant transformations. The re-suiting granulocytes fail to develop into mature lymphocytes and are released into the circulation, leading to a deficiency in the mature cells and increased susceptibility to infection. ATP-competitive inhibitors of BCR-ABL1 have been demonstrated to prevent the kinase from activating mitogenic and anti-apoptotic pathways (for example, P-3 kinase and STATS), leading to the death of the BCR-ABL1 phenotype cells and thereby providing an effective therapy against CML. The compounds of the invention, as BCR-ABL1 inhibitors, including mutants thereof, are thus especially appropriate for the therapy of diseases related to its over-expression, such as ALL or CML leukemias.

Compounds of the invention have also been demonstrated to have anti-tumor activity, in vivo: The in vivo antitumor activity is tested, for example using leukemic cell lines such as Ba/F3-BCR-ABL1, KC-22, K-562, MEG-01, KYO-1, LAMA-84, KU812, EM-2, CML-T1, BV-173, or ALL-SIL.

The present invention includes a method to treat cancer, comprising administering to a subject in need of such treatment an effective amount of a compound of the invention or a pharmaceutical composition.

A further embodiment comprises administering to the subject an additional therapeutic agent.

In a further embodiment, the additional therapeutic agent is a different BCR-ABL1 inhibitor selected from imatinib, nilotinib, dasatinib, dosutinib, ponatinib and bafetinib.

In another embodiment is a method to treat a condition mediated by BCR-ABL1, comprising administering to a subject in need thereof an effective amount of a compound of the invention or a pharmaceutical composition.

In a further embodiment, the BCR-ABL1 contains one or more mutations (UJane F. Apperley. Part 1: Mechanism of

resistance to imatinib in chronic myeloid leukaemia. *Lancet Oncology* 2007; 8:1018). Examples of such mutations include V299L, T315I, F317L, F317L, Y253F, Y253H, E255K, E255V, F359C and F359V.

In certain embodiments, the present invention relates to the aforementioned method, wherein said compound is administered parenterally.

In certain embodiments, the present invention relates to the aforementioned method, wherein said compound is administered intramuscularly, intravenously, subcutaneously, orally, pulmonary, intrathecally, topically or intranasally.

In certain embodiments, the present invention relates to the aforementioned method, wherein said compound is administered systemically.

In certain embodiments, the present invention relates to the aforementioned method, wherein said patient is a mammal.

In certain embodiments, the present invention relates to the aforementioned method, wherein said patient is a primate.

In certain embodiments, the present invention relates to the aforementioned method, wherein said patient is a human.

In another aspect, the present invention relates to a method of treating an ABL1/BCR-ABL1-mediated disorder, comprising the step of: administering to a patient in need thereof a therapeutically effective amount of a chemotherapeutic agent in combination with a therapeutically effective amount of a compound of compound of formula (I) as defined in the Summary of the Invention.

In another aspect, the present invention relates to a method of treating a ABL1/BCR-ABL1-mediated disorder, comprising the step of: administering to a patient in need thereof a therapeutically effective amount of a chemotherapeutic agent in combination with a therapeutically effective amount of a compound of compound of formula (I).

#### Pharmaceutical Compositions

In another aspect, the present invention provides pharmaceutically acceptable compositions which comprise a therapeutically-effective amount of one or more of the compounds described above, formulated together with one or more pharmaceutically acceptable carriers (additives) and/or diluents. As described in detail below, the pharmaceutical compositions of the present invention may be specially formulated for administration in solid or liquid form, including those adapted for the following: (1) oral administration, for example, drenches (aqueous or non-aqueous solutions or suspensions), tablets, e.g., those targeted for buccal, sublingual, and systemic absorption, boluses, powders, granules, pastes for application to the tongue; (2) parenteral administration, for example, by subcutaneous, intramuscular, intravenous or epidural injection as, for example, a sterile solution or suspension, or sustained-release formulation; (3) topical application, for example, as a cream, ointment, or a controlled-release patch or spray applied to the skin; (4) intravaginally or intrarectally, for example, as a pessary, cream or foam; (5) sublingually; (6) ocularly; (7) transdermally; (8) nasally; (9) pulmonary; or (10) intrathecally.

The phrase "therapeutically-effective amount" as used herein means that amount of a compound, material, or composition comprising a compound of the present invention which is effective for producing some desired therapeutic

effect in at least a sub-population of cells in an animal at a reasonable benefit/risk ratio applicable to any medical treatment.

The phrase "pharmaceutically acceptable" is employed herein to refer to those compounds, materials, compositions, and/or dosage forms which are, within the scope of sound medical judgment, suitable for use in contact with the tissues of human beings and animals without excessive toxicity, irritation, allergic response, or other problem or complication, commensurate with a reasonable benefit/risk ratio.

The phrase "pharmaceutically-acceptable carrier" as used herein means a pharmaceutically-acceptable material, composition or vehicle, such as a liquid or solid filler, diluent, excipient, manufacturing aid (e.g., lubricant, talc magnesium, calcium or zinc stearate, or steric acid), or solvent encapsulating material, involved in carrying or transporting the subject compound from one organ, or portion of the body, to another organ, or portion of the body. Each carrier must be "acceptable" in the sense of being compatible with the other ingredients of the formulation and not injurious to the patient. Some examples of materials which can serve as pharmaceutically-acceptable carriers include: (1) sugars, such as lactose, glucose and sucrose; (2) starches, such as corn starch and potato starch; (3) cellulose, and its derivatives, such as sodium carboxymethyl cellulose, ethyl cellulose and cellulose acetate; (4) powdered tragacanth; (5) malt; (6) gelatin; (7) talc; (8) excipients, such as cocoa butter and suppository waxes; (9) oils, such as peanut oil, cottonseed oil, safflower oil, sesame oil, olive oil, corn oil and soybean oil; (10) glycols, such as propylene glycol; (11) polyols, such as glycerin, sorbitol, mannitol and polyethylene glycol; (12) esters, such as ethyl oleate and ethyl laurate; (13) agar; (14) buffering agents, such as magnesium hydroxide and aluminum hydroxide; (15) alginic acid; (16) pyrogen-free water; (17) isotonic saline; (18) Ringer's solution; (19) ethyl alcohol; (20) pH buffered solutions; (21) polyesters, polycarbonates and/or polyanhydrides; and (22) other non-toxic compatible substances employed in pharmaceutical formulations.

As set out above, certain embodiments of the present compounds may contain a basic functional group, such as amino or alkylamino, and are, thus, capable of forming pharmaceutically-acceptable salts with pharmaceutically-acceptable acids. The term "pharmaceutically-acceptable salts" in this respect, refers to the relatively non-toxic, inorganic and organic acid addition salts of compounds of the present invention. These salts can be prepared in situ in the administration vehicle or the dosage form manufacturing process, or by separately reacting a purified compound of the invention in its free base form with a suitable organic or inorganic acid, and isolating the salt thus formed during subsequent purification. Representative salts include the hydrobromide, hydrochloride, sulfate, bisulfate, phosphate, nitrate, acetate, valerate, oleate, palmitate, stearate, laurate, benzoate, lactate, phosphate, tosylate, citrate, maleate, fumarate, succinate, tartrate, naphthylate, mesylate, glucoheptonate, lactobionate, and laurylsulphonate salts and the like. (See, for example, Berge et al. (1977) "Pharmaceutical Salts", *J. Pharm. Sci.* 66:1-19).

The pharmaceutically acceptable salts of the subject compounds include the conventional nontoxic salts or quaternary ammonium salts of the compounds, e.g., from non-toxic organic or inorganic acids. For example, such conventional

nontoxic salts include those derived from inorganic acids such as hydrochloride, hydrobromic, sulfuric, sulfamic, phosphoric, nitric, and the like; and the salts prepared from organic acids such as acetic, propionic, succinic, glycolic, stearic, lactic, malic, tartaric, citric, ascorbic, palmitic, maleic, hydroxymaleic, phenylacetic, glutamic, benzoic, salicylic, sulfanilic, 2-acetoxybenzoic, fumaric, toluene-sulfonic, methanesulfonic, ethane disulfonic, oxalic, isothionic, and the like.

In other cases, the compounds of the present invention may contain one or more acidic functional groups and, thus, are capable of forming pharmaceutically-acceptable salts with pharmaceutically-acceptable bases. The term "pharmaceutically-acceptable salts" in these instances refers to the relatively non-toxic, inorganic and organic base addition salts of compounds of the present invention. These salts can likewise be prepared in situ in the administration vehicle or the dosage form manufacturing process, or by separately reacting the purified compound in its free acid form with a suitable base, such as the hydroxide, carbonate or bicarbonate of a pharmaceutically-acceptable metal cation, with ammonia, or with a pharmaceutically-acceptable organic primary, secondary or tertiary amine. Representative alkali or alkaline earth salts include the lithium, sodium, potassium, calcium, magnesium, and aluminum salts and the like. Representative organic amines useful for the formation of base addition salts include ethylamine, diethylamine, ethylenediamine, ethanolamine, diethanolamine, piperazine and the like. (See, for example, Berge et al., supra)

Wetting agents, emulsifiers and lubricants, such as sodium lauryl sulfate and magnesium stearate, as well as coloring agents, release agents, coating agents, sweetening, flavoring and perfuming agents, preservatives and antioxidants can also be present in the compositions.

Examples of pharmaceutically-acceptable antioxidants include: (1) water soluble antioxidants, such as ascorbic acid, cysteine hydrochloride, sodium bisulfate, sodium metabisulfite, sodium sulfite and the like; (2) oil-soluble antioxidants, such as ascorbyl palmitate, butylated hydroxyanisole (BHA), butylated hydroxytoluene (BHT), lecithin, propyl gallate, alpha-tocopherol, and the like; and (3) metal chelating agents, such as citric acid, ethylenediamine tetraacetic acid (EDTA), sorbitol, tartaric acid, phosphoric acid, and the like.

Formulations of the present invention include those suitable for oral, nasal, topical (including buccal and sublingual), rectal, vaginal and/or parenteral administration. The formulations may conveniently be presented in unit dosage form and may be prepared by any methods well known in the art of pharmacy. The amount of active ingredient which can be combined with a carrier material to produce a single dosage form will vary depending upon the host being treated, the particular mode of administration. The amount of active ingredient which can be combined with a carrier material to produce a single dosage form will generally be that amount of the compound which produces a therapeutic effect. Generally, out of one hundred percent, this amount will range from about 0.1 percent to about ninety-nine percent of active ingredient, preferably from about 5 percent to about 70 percent, most preferably from about 10 percent to about 30 percent.

In certain embodiments, a formulation of the present invention comprises an excipient selected from the group consisting of cyclodextrins, celluloses, liposomes, micelle forming agents, e.g., bile acids, and polymeric carriers, e.g., polyesters and polyanhydrides; and a compound of the present invention. In certain embodiments, an aforementioned formulation renders orally bioavailable a compound of the present invention.

Methods of preparing these formulations or compositions include the step of bringing into association a compound of the present invention with the carrier and, optionally, one or more accessory ingredients. In general, the formulations are prepared by uniformly and intimately bringing into association a compound of the present invention with liquid carriers, or finely divided solid carriers, or both, and then, if necessary, shaping the product.

Formulations of the invention suitable for oral administration may be in the form of capsules, cachets, pills, tablets, lozenges (using a flavored basis, usually sucrose and acacia or tragacanth), powders, granules, or as a solution, suspension or solid dispersion in an aqueous or non-aqueous liquid, or as an oil-in-water or water-in-oil liquid emulsion, or as an elixir or syrup, or as pastilles (using an inert base, such as gelatin and glycerin, or sucrose and acacia) and/or as mouth washes and the like, each containing a predetermined amount of a compound of the present invention as an active ingredient. A compound of the present invention may also be administered as a bolus, electuary or paste.

In solid dosage forms of the invention for oral administration (capsules, tablets, pills, dragees, powders, granules, trouches and the like), the active ingredient is mixed with one or more pharmaceutically-acceptable carriers, such as sodium citrate or dicalcium phosphate, and/or any of the following: (1) fillers or extenders, such as starches, lactose, sucrose, glucose, mannitol, and/or silicic acid; (2) binders, such as, for example, carboxymethylcellulose, alginates, gelatin, polyvinyl pyrrolidone, sucrose and/or acacia; (3) humectants, such as glycerol; (4) disintegrating agents, such as agar-agar, calcium carbonate, potato or tapioca starch, alginic acid, certain silicates, and sodium carbonate; (5) solution retarding agents, such as paraffin; (6) absorption accelerators, such as quaternary ammonium compounds and surfactants, such as poloxamer and sodium lauryl sulfate; (7) wetting agents, such as, for example, cetyl alcohol, glycerol monostearate, and non-ionic surfactants; (8) absorbents, such as kaolin and bentonite clay; (9) lubricants, such as talc, calcium stearate, magnesium stearate, solid polyethylene glycols, sodium lauryl sulfate, zinc stearate, sodium stearate, stearic acid, and mixtures thereof; (10) coloring agents; and (11) controlled release agents such as crospovidone or ethyl cellulose. In the case of capsules, tablets and pills, the pharmaceutical compositions may also comprise buffering agents. Solid compositions of a similar type may also be employed as fillers in soft and hard-shelled gelatin capsules using such excipients as lactose or milk sugars, as well as high molecular weight polyethylene glycols and the like.

A tablet may be made by compression or molding, optionally with one or more accessory ingredients. Compressed tablets may be prepared using binder (for example, gelatin or hydroxypropylmethyl cellulose), lubricant, inert diluent, preservative, disintegrant (for example, sodium starch glycolate

or cross-linked sodium carboxymethyl cellulose), surface-active or dispersing agent. Molded tablets may be made by molding in a suitable machine a mixture of the powdered compound moistened with an inert liquid diluent.

The tablets, and other solid dosage forms of the pharmaceutical compositions of the present invention, such as dragees, capsules, pills and granules, may optionally be scored or prepared with coatings and shells, such as enteric coatings and other coatings well known in the pharmaceutical-formulating art. They may also be formulated so as to provide slow or controlled release of the active ingredient therein using, for example, hydroxypropylmethyl cellulose in varying proportions to provide the desired release profile, other polymer matrices, liposomes and/or microspheres. They may be formulated for rapid release, e.g., freeze-dried. They may be sterilized by, for example, filtration through a bacteria-retaining filter, or by incorporating sterilizing agents in the form of sterile solid compositions which can be dissolved in sterile water, or some other sterile injectable medium immediately before use. These compositions may also optionally contain opacifying agents and may be of a composition that they release the active ingredient(s) only, or preferentially, in a certain portion of the gastrointestinal tract, optionally, in a delayed manner. Examples of embedding compositions which can be used include polymeric substances and waxes. The active ingredient can also be in micro-encapsulated form, if appropriate, with one or more of the above-described excipients.

Liquid dosage forms for oral administration of the compounds of the invention include pharmaceutically acceptable emulsions, microemulsions, solutions, suspensions, syrups and elixirs. In addition to the active ingredient, the liquid dosage forms may contain inert diluents commonly used in the art, such as, for example, water or other solvents, solubilizing agents and emulsifiers, such as ethyl alcohol, isopropyl alcohol, ethyl carbonate, ethyl acetate, benzyl alcohol, benzyl benzoate, propylene glycol, 1,3-butylene glycol, oils (in particular, cottonseed, groundnut, corn, germ, olive, castor and sesame oils), glycerol, tetrahydrofuryl alcohol, polyethylene glycols and fatty acid esters of sorbitan, and mixtures thereof.

Besides inert diluents, the oral compositions can also include adjuvants such as wetting agents, emulsifying and suspending agents, sweetening, flavoring, coloring, perfuming and preservative agents.

Suspensions, in addition to the active compounds, may contain suspending agents as, for example, ethoxylated isostearyl alcohols, polyoxyethylene sorbitol and sorbitan esters, microcrystalline cellulose, aluminum metahydroxide, bentonite, agar-agar and tragacanth, and mixtures thereof.

Formulations of the pharmaceutical compositions of the invention for rectal or vaginal administration may be presented as a suppository, which may be prepared by mixing one or more compounds of the invention with one or more suitable nonirritating excipients or carriers comprising, for example, cocoa butter, polyethylene glycol, a suppository wax or a salicylate, and which is solid at room temperature, but liquid at body temperature and, therefore, will melt in the rectum or vaginal cavity and release the active compound.

Formulations of the present invention which are suitable for vaginal administration also include pessaries, tampons,

creams, gels, pastes, foams or spray formulations containing such carriers as are known in the art to be appropriate.

Dosage forms for the topical or transdermal administration of a compound of this invention include powders, sprays, ointments, pastes, creams, lotions, gels, solutions, patches and inhalants. The active compound may be mixed under sterile conditions with a pharmaceutically-acceptable carrier, and with any preservatives, buffers, or propellants which may be required.

The ointments, pastes, creams and gels may contain, in addition to an active compound of this invention, excipients, such as animal and vegetable fats, oils, waxes, paraffins, starch, tragacanth, cellulose derivatives, polyethylene glycols, silicones, bentonites, silicic acid, talc and zinc oxide, or mixtures thereof.

Powders and sprays can contain, in addition to a compound of this invention, excipients such as lactose, talc, silicic acid, aluminum hydroxide, calcium silicates and polyamide powder, or mixtures of these substances. Sprays can additionally contain customary propellants, such as chlorofluorohydrocarbons and volatile unsubstituted hydrocarbons, such as butane and propane.

Transdermal patches have the added advantage of providing controlled delivery of a compound of the present invention to the body. Such dosage forms can be made by dissolving or dispersing the compound in the proper medium. Absorption enhancers can also be used to increase the flux of the compound across the skin. The rate of such flux can be controlled by either providing a rate controlling membrane or dispersing the compound in a polymer matrix or gel.

Ophthalmic formulations, eye ointments, powders, solutions and the like, are also contemplated as being within the scope of this invention.

Pharmaceutical compositions of this invention suitable for parenteral administration comprise one or more compounds of the invention in combination with one or more pharmaceutically-acceptable sterile isotonic aqueous or nonaqueous solutions, dispersions, suspensions or emulsions, or sterile powders which may be reconstituted into sterile injectable solutions or dispersions just prior to use, which may contain sugars, alcohols, antioxidants, buffers, bacteriostats, solutes which render the formulation isotonic with the blood of the intended recipient or suspending or thickening agents.

Examples of suitable aqueous and nonaqueous carriers which may be employed in the pharmaceutical compositions of the invention include water, ethanol, polyols (such as glycerol, propylene glycol, polyethylene glycol, and the like), and suitable mixtures thereof, vegetable oils, such as olive oil, and injectable organic esters, such as ethyl oleate. Proper fluidity can be maintained, for example, by the use of coating materials, such as lecithin, by the maintenance of the required particle size in the case of dispersions, and by the use of surfactants.

These compositions may also contain adjuvants such as preservatives, wetting agents, emulsifying agents and dispersing agents. Prevention of the action of microorganisms upon the subject compounds may be ensured by the inclusion of various antibacterial and antifungal agents, for example, paraben, chlorobutanol, phenol sorbic acid, and the like. It may also be desirable to include isotonic agents, such as sugars, sodium chloride, and the like into the compositions. In

addition, prolonged absorption of the injectable pharmaceutical form may be brought about by the inclusion of agents which delay absorption such as aluminum monostearate and gelatin.

In some cases, in order to prolong the effect of a drug, it is desirable to slow the absorption of the drug from subcutaneous or intramuscular injection. This may be accomplished by the use of a liquid suspension of crystalline or amorphous material having poor water solubility. The rate of absorption of the drug then depends upon its rate of dissolution which, in turn, may depend upon crystal size and crystalline form. Alternatively, delayed absorption of a parenterally-administered drug form is accomplished by dissolving or suspending the drug in an oil vehicle.

Injectable depot forms are made by forming microcapsule matrices of the subject compounds in biodegradable polymers such as polylactide-polyglycolide. Depending on the ratio of drug to polymer, and the nature of the particular polymer employed, the rate of drug release can be controlled. Examples of other biodegradable polymers include poly(orthoesters) and poly(anhydrides). Depot injectable formulations are also prepared by entrapping the drug in liposomes or microemulsions which are compatible with body tissue.

When the compounds of the present invention are administered as pharmaceuticals, to humans and animals, they can be given per se or as a pharmaceutical composition containing, for example, 0.1 to 99% (more preferably, 10 to 30%) of active ingredient in combination with a pharmaceutically acceptable carrier.

The preparations of the present invention may be given orally, parenterally, topically, or rectally. They are of course given in forms suitable for each administration route. For example, they are administered in tablets or capsule form, by injection, inhalation, eye lotion, ointment, suppository, etc. administration by injection, infusion or inhalation; topical by lotion or ointment; and rectal by suppositories. Oral administrations are preferred.

The phrases "parenteral administration" and "administered parenterally" as used herein means modes of administration other than enteral and topical administration, usually by injection, and includes, without limitation, intravenous, intramuscular, intraarterial, intrathecal, intracapsular, intraorbital, intracardiac, intradermal, intraperitoneal, transtracheal, subcutaneous, subcuticular, intraarticular, subcapsular, subarachnoid, intraspinal and intrasternal injection and infusion.

The phrases "systemic administration," "administered systemically," "peripheral administration" and "administered peripherally" as used herein mean the administration of a compound, drug or other material other than directly into the central nervous system, such that it enters the patient's system and, thus, is subject to metabolism and other like processes, for example, subcutaneous administration.

These compounds may be administered to humans and other animals for therapy by any suitable route of administration, including orally, nasally, as by, for example, a spray, rectally, intravaginally, parenterally, intracisternally and topically, as by powders, ointments or drops, including buccally and sublingually.

Regardless of the route of administration selected, the compounds of the present invention, which may be used in a

suitable hydrated form, and/or the pharmaceutical compositions of the present invention, are formulated into pharmaceutically-acceptable dosage forms by conventional methods known to those of skill in the art.

Actual dosage levels of the active ingredients in the pharmaceutical compositions of this invention may be varied so as to obtain an amount of the active ingredient which is effective to achieve the desired therapeutic response for a particular patient, composition, and mode of administration, without being toxic to the patient.

The selected dosage level will depend upon a variety of factors including the activity of the particular compound of the present invention employed, or the ester, salt or amide thereof, the route of administration, the time of administration, the rate of excretion or metabolism of the particular compound being employed, the rate and extent of absorption, the duration of the treatment, other drugs, compounds and/or materials used in combination with the particular compound employed, the age, sex, weight, condition, general health and prior medical history of the patient being treated, and like factors well known in the medical arts.

A physician or veterinarian having ordinary skill in the art can readily determine and prescribe the effective amount of the pharmaceutical composition required. For example, the physician or veterinarian could start doses of the compounds of the invention employed in the pharmaceutical composition at levels lower than that required in order to achieve the desired therapeutic effect and gradually increase the dosage until the desired effect is achieved.

In general, a suitable daily dose of a compound of the invention will be that amount of the compound which is the lowest dose effective to produce a therapeutic effect. Such an effective dose will generally depend upon the factors described above. Generally, oral, intravenous, intracerebroventricular and subcutaneous doses of the compounds of this invention for a patient, when used for the indicated analgesic effects, will range from about 0.0001 to about 100 mg per kilogram of body weight per day.

If desired, the effective daily dose of the active compound may be administered as two, three, four, five, six or more sub-doses administered separately at appropriate intervals throughout the day, optionally, in unit dosage forms. Preferred dosing is one administration per day.

While it is possible for a compound of the present invention to be administered alone, it is preferable to administer the compound as a pharmaceutical formulation (composition).

The compounds according to the invention may be formulated for administration in any convenient way for use in human or veterinary medicine, by analogy with other pharmaceuticals.

In another aspect, the present invention provides pharmaceutically acceptable compositions which comprise a therapeutically-effective amount of one or more of the subject compounds, as described above, formulated together with one or more pharmaceutically acceptable carriers (additives) and/or diluents. As described in detail below, the pharmaceutical compositions of the present invention may be specially formulated for administration in solid or liquid form, including those adapted for the following: (1) oral administration, for example, drenches (aqueous or non-aqueous solutions or suspensions), tablets, boluses, powders, granules, pastes for

application to the tongue; (2) parenteral administration, for example, by subcutaneous, intramuscular or intravenous injection as, for example, a sterile solution or suspension; (3) topical application, for example, as a cream, ointment or spray applied to the skin, lungs, or mucous membranes; or (4) intravaginally or intrarectally, for example, as a pessary, cream or foam; (5) sublingually or buccally; (6) ocularly; (7) transdermally; or (8) nasally.

The term "treatment" is intended to encompass also prophylaxis, therapy and cure.

The patient receiving this treatment is any animal in need, including primates, in particular humans, and other mammals such as equines, cattle, swine and sheep; and poultry and pets in general.

Microemulsification technology can improve bioavailability of some lipophilic (water insoluble) pharmaceutical agents. Examples include Trimetrine (Dordunoo, S. K., et al., Drug Development and Industrial Pharmacy, 17(12), 1685-1713, 1991 and REV 5901 (Sheen, P. C., et al., J Pharm Sci 80(7), 712-714, 1991). Among other things, microemulsification provides enhanced bioavailability by preferentially directing absorption to the lymphatic system instead of the circulatory system, which thereby bypasses the liver, and prevents destruction of the compounds in the hepatobiliary circulation.

While all suitable amphiphilic carriers are contemplated, the presently preferred carriers are generally those that have Generally-Recognized-as-Safe (GRAS) status, and that can both solubilize the compound of the present invention and microemulsify it at a later stage when the solution comes into a contact with a complex water phase (such as one found in human gastrointestinal tract). Usually, amphiphilic ingredients that satisfy these requirements have HLB (hydrophilic to lipophilic balance) values of 2-20, and their structures contain straight chain aliphatic radicals in the range of C-6 to C-20. Examples are polyethylene-glycolized fatty glycerides and polyethylene glycols.

Commercially available amphiphilic carriers are particularly contemplated, including Gelucire-series, Labrafil, Labrasol, or Lauroglycol (all manufactured and distributed by Gattefosse Corporation, Saint Priest, France), PEG-mono-oleate, PEG-di-oleate, PEG-mono-laurate and di-laurate, Lecithin, Polysorbate 80, etc (produced and distributed by a number of companies in USA and worldwide).

Hydrophilic polymers suitable for use in the present invention are those which are readily water-soluble, can be covalently attached to a vesicle-forming lipid, and which are tolerated in vivo without toxic effects (i.e., are biocompatible). Suitable polymers include polyethylene glycol (PEG), polylactic (also termed polylactide), polyglycolic acid (also termed polyglycolide), a polylactic-polyglycolic acid copolymer, and polyvinyl alcohol. Preferred polymers are those having a molecular weight of from about 100 or 120 daltons up to about 5,000 or 10,000 daltons, and more preferably from about 300 daltons to about 5,000 daltons. In a particularly preferred embodiment, the polymer is polyethyleneglycol having a molecular weight of from about 100 to about 5,000 daltons, and more preferably having a molecular weight of from about 300 to about 5,000 daltons. In a particularly preferred embodiment, the polymer is polyethyleneglycol of 750 daltons (PEG(750)). Polymers may also be defined

by the number of monomers therein; a preferred embodiment of the present invention utilizes polymers of at least about three monomers, such as PEG polymers consisting of three monomers (approximately 150 daltons).

Other hydrophilic polymers which may be suitable for use in the present invention include polyvinylpyrrolidone, polymethoxazoline, polyethyloxazoline, polyhydroxypropyl methacrylamide, polymethacrylamide, polydimethylacrylamide, and derivatized celluloses such as hydroxymethylcellulose or hydroxyethylcellulose.

In certain embodiments, a formulation of the present invention comprises a biocompatible polymer selected from the group consisting of polyamides, polycarbonates, polyalkylenes, polymers of acrylic and methacrylic esters, polyvinyl polymers, polyglycolides, polysiloxanes, polyurethanes and co-polymers thereof, celluloses, polypropylene, polyethylenes, polystyrene, polymers of lactic acid and glycolic acid, polyanhydrides, poly(ortho)esters, poly(butic acid), poly(valeric acid), poly(lactide-co-caprolactone), polysaccharides, proteins, polyhyaluronic acids, polycyanoacrylates, and blends, mixtures, or copolymers thereof.

Cyclodextrins are cyclic oligosaccharides, consisting of 6, 7 or 8 glucose units, designated by the Greek letter alpha, beta or gamma, respectively. Cyclodextrins with fewer than six glucose units are not known to exist. The glucose units are linked by alpha-1,4-glucosidic bonds. As a consequence of the chair conformation of the sugar units, all secondary hydroxyl groups (at C-2, C-3) are located on one side of the ring, while all the primary hydroxyl groups at C-6 are situated on the other side. As a result, the external faces are hydrophilic, making the cyclodextrins water-soluble. In contrast, the cavities of the cyclodextrins are hydrophobic, since they are lined by the hydrogen of atoms C-3 and C-5, and by ether-like oxygens. These matrices allow complexation with a variety of relatively hydrophobic compounds, including, for instance, steroid compounds such as 17-beta-estradiol (see, e.g., van Uden et al. Plant Cell Tiss. Org. Cult. 38:1-3-113 (1994)). The complexation takes place by Van der Waals interactions and by hydrogen bond formation. For a general review of the chemistry of cyclodextrins, see, Wenz, Agnew. Chem. Int. Ed. Engl., 33:803-822 (1994).

The physico-chemical properties of the cyclodextrin derivatives depend strongly on the kind and the degree of substitution. For example, their solubility in water ranges from insoluble (e.g., triacetyl-beta-cyclodextrin) to 147% soluble (w/v) (G-2-beta-cyclodextrin). In addition, they are soluble in many organic solvents. The properties of the cyclodextrins enable the control over solubility of various formulation components by increasing or decreasing their solubility.

Numerous cyclodextrins and methods for their preparation have been described. For example, Parmeter (I), et al. (U.S. Pat. No. 3,453,259) and Gramera, et al. (U.S. Pat. No. 3,459,731) described electroneutral cyclodextrins. Other derivatives include cyclodextrins with cationic properties [Parmeter (II), U.S. Pat. No. 3,453,257], insoluble crosslinked cyclodextrins (Solms, U.S. Pat. No. 3,420,788), and cyclodextrins with anionic properties [Parmeter (III), U.S. Pat. No. 3,426,011]. Among the cyclodextrin derivatives with anionic properties, carboxylic acids, phosphorous acids, phosphinous acids, phosphonic acids, phosphoric acids, thiophosphonic

acids, thiosulphonic acids, and sulfonic acids have been appended to the parent cyclodextrin [see, Parmeter (III), supra]. Furthermore, sulfoalkyl ether cyclodextrin derivatives have been described by Stella, et al. (U.S. Pat. No. 5,134,127).

Liposomes consist of at least one lipid bilayer membrane enclosing an aqueous internal compartment. Liposomes may be characterized by membrane type and by size. Small unilamellar vesicles (SUVs) have a single membrane and typically range between 0.02 and 0.05  $\mu\text{m}$  in diameter; large unilamellar vesicles (LUVs) are typically larger than 0.05  $\mu\text{m}$ . Oligolamellar large vesicles and multilamellar vesicles have multiple, usually concentric, membrane layers and are typically larger than 0.1  $\mu\text{m}$ . Liposomes with several nonconcentric membranes, i.e., several smaller vesicles contained within a larger vesicle, are termed multivesicular vesicles.

One aspect of the present invention relates to formulations comprising liposomes containing a compound of the present invention, where the liposome membrane is formulated to provide a liposome with increased carrying capacity. Alternatively or in addition, the compound of the present invention may be contained within, or adsorbed onto, the liposome bilayer of the liposome. The compound of the present invention may be aggregated with a lipid surfactant and carried within the liposome's internal space; in these cases, the liposome membrane is formulated to resist the disruptive effects of the active agent-surfactant aggregate.

According to one embodiment of the present invention, the lipid bilayer of a liposome contains lipids derivatized with polyethylene glycol (PEG), such that the PEG chains extend from the inner surface of the lipid bilayer into the interior space encapsulated by the liposome, and extend from the exterior of the lipid bilayer into the surrounding environment.

Active agents contained within liposomes of the present invention are in solubilized form. Aggregates of surfactant and active agent (such as emulsions or micelles containing the active agent of interest) may be entrapped within the interior space of liposomes according to the present invention. A surfactant acts to disperse and solubilize the active agent, and may be selected from any suitable aliphatic, cycloaliphatic or aromatic surfactant, including but not limited to biocompatible lysophosphatidylcholines (LPCs) of varying chain lengths (for example, from about C.sub.14 to about C.sub.20). Polymer-derivatized lipids such as PEG-lipids may also be utilized for micelle formation as they will act to inhibit micelle/membrane fusion, and as the addition of a polymer to surfactant molecules decreases the CMC of the surfactant and aids in micelle formation. Preferred are surfactants with CMCs in the micromolar range; higher CMC surfactants may be utilized to prepare micelles entrapped within liposomes of the present invention, however, micelle surfactant monomers could affect liposome bilayer stability and would be a factor in designing a liposome of a desired stability.

Liposomes according to the present invention may be prepared by any of a variety of techniques that are known in the art. See, e.g., U.S. Pat. No. 4,235,871; Published PCT applications WO 96/14057; New RRC, Liposomes: A practical approach, IRL Press, Oxford (1990), pages 33-104; Lasic DD, Liposomes from physics to applications, Elsevier Science Publishers BV, Amsterdam, 1993.

For example, liposomes of the present invention may be prepared by diffusing a lipid derivatized with a hydrophilic

polymer into preformed liposomes, such as by exposing preformed liposomes to micelles composed of lipid-grafted polymers, at lipid concentrations corresponding to the final mole percent of derivatized lipid which is desired in the liposome. Liposomes containing a hydrophilic polymer can also be formed by homogenization, lipid-field hydration, or extrusion techniques, as are known in the art.

In one aspect of the present invention, the liposomes are prepared to have substantially homogeneous sizes in a selected size range. One effective sizing method involves extruding an aqueous suspension of the liposomes through a series of polycarbonate membranes having a selected uniform pore size; the pore size of the membrane will correspond roughly with the largest sizes of liposomes produced by extrusion through that membrane. See e.g., U.S. Pat. No. 4,737,323 (Apr. 12, 1988).

The release characteristics of a formulation of the present invention depend on the encapsulating material, the concentration of encapsulated drug, and the presence of release modifiers. For example, release can be manipulated to be pH dependent, for example, using a pH sensitive coating that releases only at a low pH, as in the stomach, or a higher pH, as in the intestine. An enteric coating can be used to prevent release from occurring until after passage through the stomach. Multiple coatings or mixtures of cyanamide encapsulated in different materials can be used to obtain an initial release in the stomach, followed by later release in the intestine. Release can also be manipulated by inclusion of salts or pore forming agents, which can increase water uptake or release of drug by diffusion from the capsule. Excipients which modify the solubility of the drug can also be used to control the release rate. Agents which enhance degradation of the matrix or release from the matrix can also be incorporated. They can be added to the drug, added as a separate phase (i.e., as particulates), or can be co-dissolved in the polymer phase depending on the compound. In all cases the amount should be between 0.1 and thirty percent (w/w polymer). Types of degradation enhancers include inorganic salts such as ammonium sulfate and ammonium chloride, organic acids such as citric acid, benzoic acid, and ascorbic acid, inorganic bases such as sodium carbonate, potassium carbonate, calcium carbonate, zinc carbonate, and zinc hydroxide, and organic bases such as protamine sulfate, spermine, choline, ethanolamine, diethanolamine, and triethanolamine and surfactants such as Tween® and Pluronic®. Pore forming agents which add microstructure to the matrices (i.e., water soluble compounds such as inorganic salts and sugars) are added as particulates. The range should be between one and thirty percent (w/w polymer).

Uptake can also be manipulated by altering residence time of the particles in the gut. This can be achieved, for example, by coating the particle with, or selecting as the encapsulating material, a mucosal adhesive polymer. Examples include most polymers with free carboxyl groups, such as chitosan, celluloses, and especially polyacrylates (as used herein, polyacrylates refers to polymers including acrylate groups and modified acrylate groups such as cyanoacrylates and methacrylates).

#### Pharmaceutical Combinations

The invention especially relates to the use of a compound of the formula (I) (or a pharmaceutical composition compris-

ing a compound of the formula (I) in the treatment of one or more of the diseases mentioned herein; wherein the response to treatment is beneficial as demonstrated, for example, by the partial or complete removal of one or more of the symptoms of the disease up to complete cure or remission.

Philadelphia chromosome positive (Ph+) ALL accounts for 15-30% of adult ALL and up to 5% of pediatric ALL (Faderl S, Garcia-MAnero G, Thomas D, et al. Philadelphia Chromosome Positive Acute Lymphoblastic Leukemia—Current Concepts and Future Perspectives. *Rev Clin Exp Hematol* 2002; 6:142-160). Pediatric Ph+ ALL is characterized by an older age (median 9-10 years versus approximately 4 years for all ALL patients) and higher WBC counts at diagnosis. In both adults and children, Ph+ ALL is characterized by a reciprocal translocation between chromosomes 9 and 22 (t(9;22)(q34;q11)) resulting in fusion of the BCR gene on chromosome 22 with ABL gene sequences translocated from chromosome 9, resulting in expression of the BCR-ABL1 protein. There are 2 primary variants of BCR-ABL1, p190BCR-ABL1, detectable in approximately 85% of Ph+ ALL patients, and p210 BCR-ABL1, typical of CML, identified in approximately 15% of Ph+ ALL patients (Dombret H, Galbert J, Boiron J, et al. Outcome of Treatment in Adults with Philadelphia chromosome-positive acute lymphoblastic leukemia—Results of the prospective multicenter LALA-94 trial. *Blood* 2002; 100:2357-2366; Faderl S, Garcia-MAnero G, Thomas D, et al. Philadelphia Chromosome Positive Acute Lymphoblastic Leukemia—Current Concepts and Future Perspectives. *Rev Clin Exp Hematol* 2002; 6:142-160).

The treatment of ALL is based on each patient's risk classification, with increasingly intensive treatment for patients who are at higher risk of relapse; this strategy maximizes remission rates while limiting unnecessary toxicities. Progress has been incremental, from the introduction of combination chemotherapy and treatment for pre-symptomatic central nervous system leukemia to newer, intensive treatment regimens for patients at high risk for relapse (C. H. Pui and W. E. Evans. *Acute Lymphoblastic Leukemia* *New Engl J Med* 1998; 339:605-615). Prior to the development of imatinib, Ph+ ALL patients were treated with intensive chemotherapy followed by hematopoietic stem cell transplant (HSCT), ideally with a matched related donor, as this was shown to result in improved EFS versus either HSCT with other donors or chemotherapy alone. Overall, and in contrast to the majority of pediatric patients with ALL, patients with Ph+ ALL have had a dire prognosis with low rates of event free survival (EFS) (Arico M, Valsecchi M G, Camitta B, Schrappe M, Chessells J, Baruchel A, Gaynon P, Silverman L, Janka-Schaub G, Kamps W, et al. *New Engl J Med* 2000; 342:998-1006).

A compound of formula (I) can also be used in combination with other antineoplastic compounds. Such compounds include, but are not limited to ribonucleotide reductase inhibitors, topoisomerase I inhibitors; topoisomerase II inhibitors; microtubule active compounds; alkylating compounds; histone deacetylase inhibitors; mTOR inhibitors, such as RAD001; antineoplastic antimetabolites; platin compounds; compounds targeting/decreasing a protein or lipid kinase activity methionine aminopeptidase inhibitors; biological response modifiers; inhibitors of Ras oncogenic isoforms;

telomerase inhibitors; proteasome inhibitors; compounds used in the treatment of hematologic malignancies, such as FLUDARABINE; compounds which target, decrease or inhibit the activity of PKC, such as midostaurin; HSP90 inhibitors such as 17-AAG (17-allylaminogeldanamycin, NSC330507), 17-DMAG (17-dimethylaminoethylamino-17-demethoxy-geldanamycin, NSC707545), IPI-504, CNF1010, CNF2024, CNF1010 from Conforma Therapeutics, HSP990 and AUY922; temozolomide (TEMODAL®); kinesin spindle protein inhibitors, such as SB715992 or SB743921 from GlaxoSmithKline, or pentamidine/chlorpromazine from CombinatoRx; PI3K inhibitors, such as BEZ235, BKM120 or BYL719; MEK inhibitors such as ARRY142886 from Array BioPharma, AZD6244 from AstraZeneca, PD181461 from Pfizer, leucovorin, EDG binders, antileukemia compounds, S-adenosylmethionine decarboxylase inhibitors, antiproliferative antibodies or other chemotherapeutic compounds. Further, alternatively or in addition they may be used in combination with ionizing radiation

The term "ribonucleotide reductase inhibitors" refers to pyrimidine or purine nucleoside analogues including, but not limited to, fludarabine and/or cytosine arabinoside (ara-C), 6-thioguanine, 5-fluorouracil, cladribine, 6-mercaptopurine (especially in combination with ara-C against ALL), clofarabine, nelarabine (a prodrug of 9- $\beta$ -arabinofuranosylguanine, ara-G), pentostatin, hydroxyurea or 2-hydroxy-1H-isoin-dole-1,3-dione derivatives (Nandy et al., *Acta Oncologica* 1994; 33:953-961).

The term "topoisomerase I inhibitor" as used herein includes, but is not limited to topotecan, gimatecan, irinotecan, camptothecin and its analogues, 9-nitrocamptothecin and the macromolecular camptothecin conjugate PNU-166148 (compound A1 in W099/17804). Irinotecan can be administered, e.g. in the form as it is marketed, e.g. under the trademark CAMPTOSAR. Topotecan can be administered, e.g., in the form as it is marketed, e.g. under the trademark HYCAMTIN.

The term "topoisomerase II inhibitor" as used herein includes, but is not limited to the anthracyclines such as doxorubicin (including liposomal formulation, e.g. CAE-LYX), daunorubicin, epirubicin, idarubicin and nemorubicin, the anthraquinones mitoxantrone and losoxantrone, and the podophyllotoxines etoposide and teniposide. Etoposide can be administered, e.g. in the form as it is marketed, e.g. under the trademark ETOPOPHOS. Teniposide can be administered, e.g. in the form as it is marketed, e.g. under the trademark VM 26-BRISTOL. Doxorubicin can be administered, e.g. in the form as it is marketed, e.g. under the trademark ADIRBLASTIN or ADRIAMYCIN. Epirubicin can be administered, in the form as it is marketed, under the trademark FARMORUBICIN. Idarubicin can be administered, e.g. in the form as it is marketed, e.g. under the trademark ZAVEDOS. Mitoxantrone can be administered, e.g. in the form as it is marketed, e.g. under the trademark NOVANTRON.

The term "microtubule active compound" relates to microtubule stabilizing, microtubule destabilizing compounds and microtubulin polymerization inhibitors including, but not limited to taxanes, e.g. paclitaxel and docetaxel, vinca alkaloids, e.g., vinblastine, especially vinblastine sulfate, vincristine especially vincristine sulfate, and vinorelbine, discoder-

molides, cochicine and epothilones and derivatives thereof, e.g. epothilone B or D or derivatives thereof. Paclitaxel may be administered e.g. in the form as it is marketed, e.g. TAXOL. Docetaxel can be administered, e.g., in the form as it is marketed, e.g. under the trademark TAXOTERE. Vinblastine sulfate can be administered, e.g., in the form as it is marketed, e.g. under the trademark VINBLASTIN R.P. Vincristine sulfate can be administered, e.g., in the form as it is marketed, e.g. under the trademark FARMISTIN. Discodermolide can be obtained, e.g., as disclosed in U.S. Pat. No. 5,010,099. Also included are Epothilone derivatives which are disclosed in WO 98/10121, U.S. Pat. No. 6,194,181, WO 98/25929, WO 98/08849, WO 99/43653, WO 98/22461 and WO 00/31247. Especially preferred are Epothilone A and/or B.

The term "alkylating compound" as used herein includes, but is not limited to, cyclophosphamide, ifosfamide, melphalan or nitrosourea (BCNU or Gliadel). Cyclophosphamide can be administered, e.g., in the form as it is marketed, e.g. under the trademark CYCLOSTIN. Ifosfamide can be administered, e.g., in the form as it is marketed, e.g. under the trademark HOLOXAN.

The term "histone deacetylase inhibitors" or "HDAC inhibitors" relates to compounds which inhibit the histone deacetylase and which possess antiproliferative activity. This includes compounds such as LDH589 disclosed in WO 02/22577, especially N-hydroxy-3-[4-[(2-hydroxyethyl)[2-(1H-indol-3-yl)ethyl]-amino]methyl]phenyl]-2E-2-propenamide, N-hydroxy-3-[4-[[[2-(2-methyl-1H-indol-3-yl)-ethyl]-amino]methyl]phenyl]-2E-2-propenamide and pharmaceutically acceptable salts thereof. It further especially includes Suberoylanilide hydroxamic acid (SAHA).

The term "antineoplastic antimetabolite" includes, but is not limited to, 5-fluorouracil or 5-FU, capecitabine, gemcitabine, DNA demethylating compounds, such as 5-azacytidine and decitabine, methotrexate and edatrexate, and folic acid antagonists such as pemetrexed. Capecitabine can be administered, e.g., in the form as it is marketed, e.g. under the trademark XELODA. Gemcitabine can be administered, e.g., in the form as it is marketed, e.g. under the trademark GEMZAR.

The term "platin compound" as used herein includes, but is not limited to, carboplatin, cis-platin, cisplatin and oxaliplatin. Carboplatin can be administered, e.g., in the form as it is marketed, e.g. under the trademark CARBOPLAT. Oxaliplatin can be administered, e.g., in the form as it is marketed, e.g. under the trademark ELOXATIN.

The term "compounds targeting/decreasing a protein or lipid kinase activity"; or a "protein or lipid phosphatase activity" as used herein includes, but is not limited to, protein tyrosine kinase and/or serine and/or threonine kinase inhibitors or lipid kinase inhibitors, for example:

a) compounds targeting, decreasing or inhibiting the activity of members of the ABL1 family, their gene-fusion products (e.g. BCR-ABL1 kinase) and mutants, such as compounds which target decrease or inhibit the activity of ABL1 family members and their gene fusion products, e.g. imatinib, nilotinib, dasatinib, bosutinib, ponatinib, bafetinib, PD180970, AG957, NSC 680410 and PD173955;

b) compounds targeting, decreasing or inhibiting the activity of members of the protein kinase C (PKC) and Raf family

of serine/threonine kinases, members of the MEK, SRC, JAK, FAK, PDK1, PKB/Akt, and Ras/MAPK family members, and/or members of the cyclin-dependent kinase family (CDK) and are especially those staurosporine derivatives disclosed in U.S. Pat. No. 5,093,330, e.g. midostaurin; examples of further compounds include e.g. UCN-01, safinolol, BAY 43-9006, Bryostatins 1, Perifosine; Ilmofofosine; RO 318220 and RO 320432; GO 6976; Isis 3521; LY333531/LY379196; isochinoline compounds such as those disclosed in WO 00/09495; FTIs; BEZ235 (a P13K inhibitor) or AT7519 (CDK inhibitor);

The term "mTOR inhibitors" relates to compounds which inhibit the mammalian target of rapamycin (mTOR) and which possess antiproliferative activity such as sirolimus (Rapamune®), everolimus (Certican™), CCI-779 and ABT578.

The term "biological response modifier" as used herein refers to a lymphokine or interferons, e.g. interferon  $\gamma$ .

The term "inhibitor of Ras oncogenic isoforms", e.g. H-Ras, K-Ras, or N-Ras, as used herein refers to compounds which target, decrease or inhibit the oncogenic activity of Ras e.g. a "farnesyl transferase inhibitor" e.g. L-744832, DK8G557 or R115777 (Zarnestra).

The term "telomerase inhibitor" as used herein refers to compounds which target, decrease or inhibit the activity of telomerase. Compounds which target, decrease or inhibit the activity of telomerase are especially compounds which inhibit the telomerase receptor, e.g. telomestatin.

The term "methionine aminopeptidase inhibitor" as used herein refers to compounds which target, decrease or inhibit the activity of methionine aminopeptidase. Compounds which target, decrease or inhibit the activity of methionine aminopeptidase are e.g. bengamide or a derivative thereof.

The term "proteasome inhibitor" as used herein refers to compounds which target, decrease or inhibit the activity of the proteasome. Compounds which target, decrease or inhibit the activity of the proteasome include e.g. Bortezomid (Velcade™) and MLN 341.

The term "HSP90 inhibitors" as used herein includes, but is not limited to, compounds targeting, decreasing or inhibiting the intrinsic ATPase activity of HSP90; degrading, targeting, decreasing or inhibiting the HSP90 client proteins via the ubiquitin proteasome pathway. Compounds targeting, decreasing or inhibiting the intrinsic ATPase activity of HSP90 are especially compounds, proteins or antibodies which inhibit the ATPase activity of HSP90 e.g., 17-allylamino, 17-demethoxygeldanamycin (17AAG), a geldanamycin derivative; other geldanamycin related compounds; radicicol and HDAC inhibitors. Example HSP90 inhibitors are HSP990 and AUY922.

For the treatment of acute myeloid leukemia (AML), compounds of formula (I) can be used in combination with standard leukemia therapies, especially in combination with therapies used for the treatment of AML. In particular, compounds of formula (I) can be administered in combination with, e.g., farnesyl transferase inhibitors and/or other drugs useful for the treatment of AML, such as Daunorubicin, Adriamycin, Ara-C, VP-16, Teniposide, Mitoxantrone, Idarubicin, Carboplatinum and PKC412.

Compounds which target, decrease or inhibit activity of histone deacetylase (HDAC) inhibitors such as sodium

83

butyrate and suberoylanilide hydroxamic acid (SAHA) inhibit the activity of the enzymes known as histone deacetylases. Specific HDAC inhibitors include MS275, SAHA, FK228 (formerly FR901228), Trichostatin A and compounds disclosed in U.S. Pat. No. 6,552,065, in particular, N-hydroxy-3-[4-[[[2-(2-methyl-1H-indol-3-yl)-ethyl]-amino]-methyl]phenyl]-2E-2-propenamide, or a pharmaceutically acceptable salt thereof and N-hydroxy-3-[4-[(2-hydroxyethyl){2-(1H-indol-3-yl)ethyl]-amino]methyl]phenyl]-2E-2-propenamide, or a pharmaceutically acceptable salt thereof, especially the lactate salt.

Tumor cell damaging approaches refer to approaches such as ionizing radiation. The term “ionizing radiation” referred to above and hereinafter means ionizing radiation that occurs as either electromagnetic rays (such as X-rays and gamma rays) or particles (such as alpha and beta particles). Ionizing radiation is provided in, but not limited to, radiation therapy and is known in the art. See Hellman, *Principles of Radiation Therapy, Cancer*, in *Principles and Practice of Oncology*, Devita et al., Eds., 4<sup>th</sup> Edition, Vol. 1, pp. 248-275 (1993).

The term “S-adenosylmethionine decarboxylase inhibitors” as used herein includes, but is not limited to the compounds disclosed in U.S. Pat. No. 5,461,076.

“Other chemotherapeutic compounds” include, but are not limited to, plant alkaloids, hormonal compounds and antagonists; biological response modifiers, preferably lymphokines or interferons; antisense oligonucleotides or oligonucleotide derivatives; shRNA or siRNA; or miscellaneous compounds or compounds with other or unknown mechanism of action.

The structure of the active compounds identified by code nos., generic or trade names may be taken from the actual

84

edition of the standard compendium “The Merck Index” or from databases, e.g. Patents International (e.g. IMS World Publications).

None of the quotations of references made within the present disclosure is to be understood as an admission that the references cited are prior art that would negatively affect the patentability of the present invention.

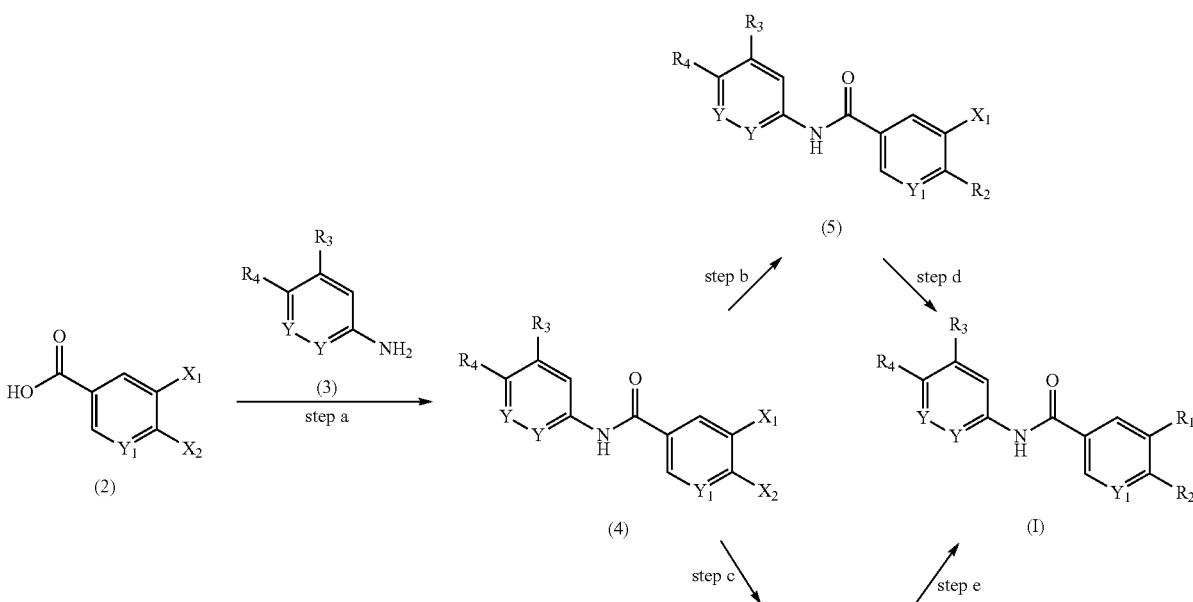
#### Processes for Making Compounds of the Invention

The present invention also includes processes for the preparation of compounds of the invention. In the reactions described, it can be necessary to protect reactive functional groups, for example hydroxy, amino, imino, thio or carboxy groups, where these are desired in the final product, to avoid their unwanted participation in the reactions. Conventional protecting groups can be used in accordance with standard practice, for example, see T. W. Greene and P. G. M. Wuts in “Protective Groups in Organic Chemistry”, John Wiley and Sons, 1991.

Where temperatures are given hereinbefore or hereinafter, “about” has to be added, as minor deviations from the numeric values given, e.g. variations of  $\pm 10\%$ , are tolerable. All reactions may take place in the presence of one or more diluents and/or solvents. The starting materials may be used in equimolar amounts; alternatively, a compound may be used in excess, e.g. to function as a solvent or to shift equilibrium or to generally accelerate reaction rates. Reaction aids, such as acids, bases or catalysts may be added in suitable amounts, as known in the field, required by a reaction and in line with generally known procedures.

Compounds of formula (I) can be prepared by proceeding as in the following Reaction Scheme I:

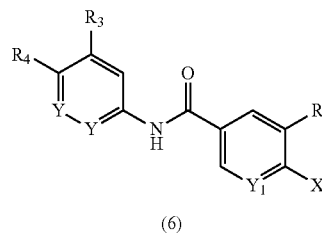
Reaction Scheme I:



85

86

-continued



in which Y, Y<sub>1</sub>, R<sub>1</sub>, R<sub>2</sub>, R<sub>3</sub> and R<sub>4</sub> are as defined for formula (I) in the Summary of the Invention and X<sub>1</sub> and X<sub>2</sub> represent halogen atoms, X<sub>1</sub> can be selected from chloro, bromo, or iodo and X<sub>2</sub> can be selected from chloro or fluoro.

Step a: A compound of formula (4) can be prepared by reacting the acid chloride from a compound of formula (2) with a compound of formula (3) in the presence of a suitable solvent (for example tetrahydrofuran, or the like), and an organic base (for example diisopropylethylamine, or the like). The reaction takes place from about 0° C. to about room temperature and can take up to about 2 hours to complete.

The acid chloride of a compound of formula (2) can be prepared with a chlorinating agent (for example thionyl chloride, or oxalyl chloride, or the like) in the presence of a catalyst (for example dimethylformamide, or the like) and a suitable solvent (for example toluene, or the like). The reaction takes place at about room temperature or by heating to about 85° C. and can take up to about 2 hours to complete.

Step b: A compound of formula (5) can be prepared by reacting a compound of formula (4) with R<sub>2</sub>—H wherein R<sub>2</sub> is as defined in the Summary of the Invention, in the presence of a suitable solvent (for example 2-propanol, or dimethyl sulfoxide, or the like), and a suitable organic base (for example diisopropylethylamine, or triethylamine, or the like). The reaction takes place at about 90° C. to about 140° C. and can take from about 30 minutes to about 72 hours to complete.

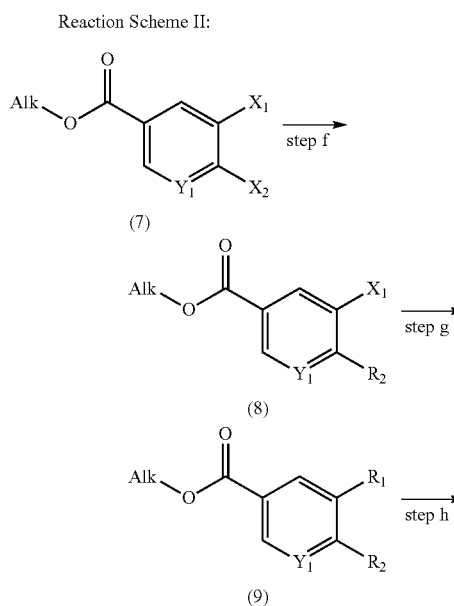
Step c: A compound of formula (6) can be prepared by reacting a compound of formula (4), X<sub>1</sub> being preferably bromo or iodo, with R<sub>1</sub>—Z<sub>1</sub>, wherein R<sub>1</sub> is as defined herein, Z<sub>1</sub> being preferably a boronic acid or ester (Suzuki reaction), in the presence of a suitable solvent (for example dimethoxyethane, or a mixture of dimethoxyethane and water, or the like), a suitable inorganic base (for example sodium carbonate, or the like), and a palladium catalyst (for example bis(triphenylphosphine)palladium(II) dichloride, or 1,1'-bis(diphenylphosphino)ferrocene-palladium(II)dichloride dichloromethane complex, or tetrakis(triphenylphosphine)palladium(0), or the like) and optionally a cosolvent (for example, ethanol, or the like). The reaction takes place from about 80° C. to about 130° C. and can take from about 20 minutes to about 18 hours to complete.

Alternatively, step c can occur by reacting a compound of formula (4), X<sub>1</sub> being preferably bromo or iodo, with R<sub>1</sub>—Z<sub>2</sub>, wherein R<sub>1</sub> is as defined herein, Z<sub>2</sub> being preferably a trialkylstannyl reagent (Stille reaction), in the presence of a suitable solvent (for example dimethyl sulfoxide, or the like), and a palladium catalyst (for example tetrakis(triphenylphosphine)palladium(0)). The reaction takes place at about 140° C. and can take up to about 24 hours to complete.

Step d: A compound of formula (I) can be prepared by reacting a compound of formula (5), X<sub>1</sub> being preferably bromo or iodo, with R<sub>1</sub>—Z<sub>1</sub>, wherein R<sub>1</sub> is as defined herein, Z<sub>1</sub> being preferably a boronic acid or ester (Suzuki reaction), in the presence of a suitable solvent (for example dimethoxyethane, or a mixture of dimethoxyethane and water, or the like), an inorganic base (for example sodium carbonate, or the like), and a palladium catalyst (for example bis(triphenylphosphine)palladium(II) dichloride, or 1,1'-bis(diphenylphosphino)ferrocene-palladium(II)dichloride dichloromethane complex, or tetrakis(triphenylphosphine)palladium(0), or the like) and optionally a cosolvent (for example, ethanol, or the like). The reaction takes place at about 80-130° C. and can take up to about 20 minutes to 2 hours to complete.

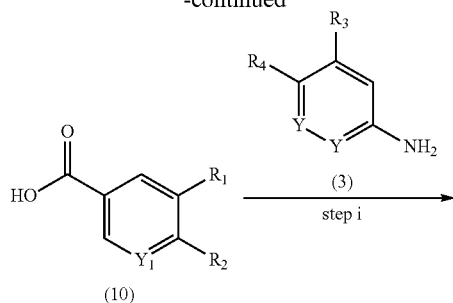
Step e: A compound of formula (I) can be prepared by reacting a compound of formula (6) with R<sub>2</sub>—H wherein R<sub>2</sub> is as defined herein, in the presence of a suitable solvent (for example 2-propanol, or dimethyl sulfoxide, or the like), an organic base (for example diisopropylethylamine, or triethylamine, or the like). The reaction takes place at about 90-140° C. and can take up to about 30 minutes to 72 hours to complete.

Compounds of formula (I) can be prepared by proceeding as in the following Reaction Scheme II:



87

-continued



in which Y, Y<sub>1</sub>, R<sub>1</sub>, R<sub>2</sub>, R<sub>3</sub> and R<sub>4</sub> are as defined for formula (I) in the Summary of the Invention and X<sub>1</sub> and X<sub>2</sub> represent halogen atoms, X<sub>1</sub> in particular chloro, bromo, or iodo, X<sub>2</sub> in particular chloro or fluoro and Alk is low alkyl chain in particular methyl.

Step f: A compound of formula (8) can be prepared by reacting a compound of formula (7) with R<sub>2</sub>—H wherein R<sub>2</sub> is as defined herein, in analogy to Step b

Step g: A compound of formula (9) can be prepared by reacting a compound of formula (8), X<sub>1</sub> being preferably bromo or iodo, with R<sub>1</sub>—Z<sub>1</sub>, where R<sub>1</sub> is as defined herein, Z<sub>1</sub> being preferably a boronic acid or ester (Suzuki reaction), in analogy to Step d.

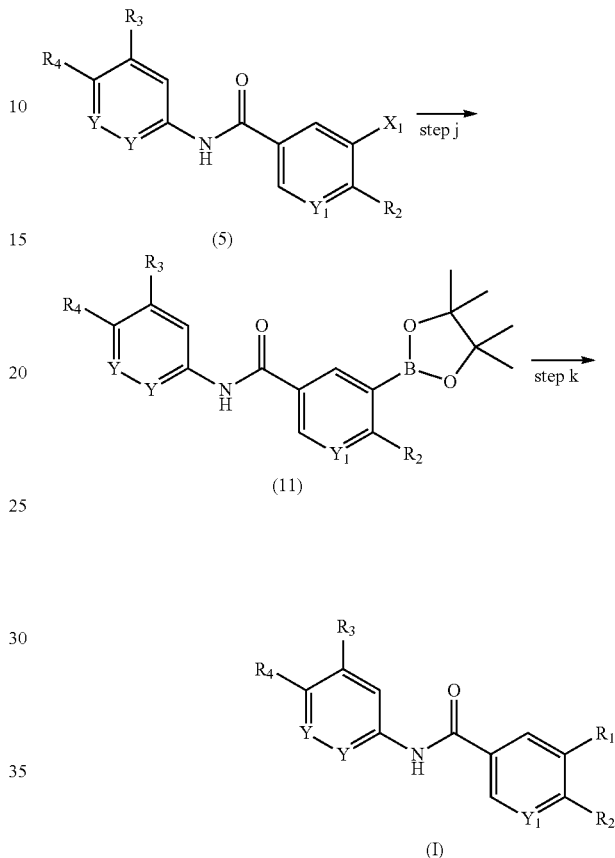
Step h: A compound of formula (10) can be prepared by hydrolysis of the ester of a compound of formula (9) in the presence of a suitable solvent (for example water, or the like), an inorganic base (for example sodium hydroxide, or the like). The reaction takes place at room temperature and can take up to about 2 hours complete.

Step i: A compound of formula (I) can be prepared by reacting a compound of (10) with a compound of formula (3) in the presence of a coupling reagent (such as 1-ethyl-3-(3-dimethylaminopropyl)carbodiimide hydrochloride and hydroxybenzotriazole, or the like), a suitable base (such as N-methylmorpholine, diisopropylethylamine, or the like) and a suitable solvent (such as dichloro methane, dimethylformamide, or the like). The reaction takes place at room temperature and can take up to about 12 hours to complete.

88

Compounds of formula (I) can be prepared by proceeding as in the following Reaction Scheme III:

5 Reaction Scheme III:



in which Y, Y<sub>1</sub>, R<sub>1</sub>, R<sub>2</sub>, R<sub>3</sub> and R<sub>4</sub> are as defined for formula (I) in the Summary of the Invention and X<sub>1</sub> and X<sub>2</sub> represent halogen atoms, X<sub>1</sub> in particular chloro, bromo, or iodo, X<sub>2</sub> in particular chloro or fluoro.

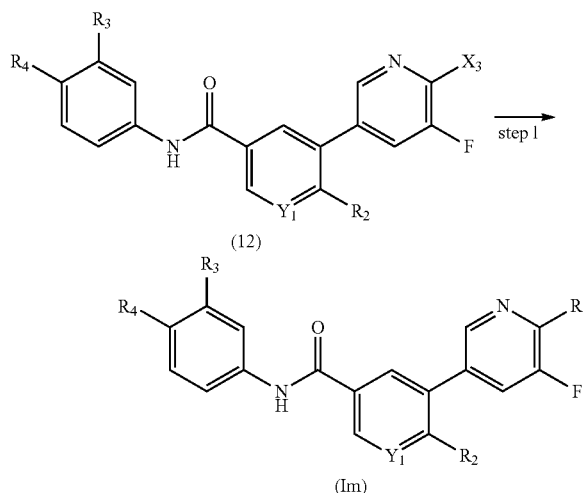
Step j: A compound of formula (11) can be prepared by reacting a compound of formula (5), X<sub>1</sub> being preferably bromo, with bis(pinacolato)diboron, in the presence of a suitable solvent (for example dioxane, or the like), an inorganic base (for example tripotassium carbonate, or the like), and a palladium catalyst (for example bis(triphenylphosphine)palladium(II) dichloride, or the like). The reaction takes place at about 50-65° C. and can take up to 32 hours to complete.

Step k: A compound of formula (I) can be prepared by reacting a compound of formula (11) with R<sub>1</sub>-X<sub>3</sub>, X<sub>3</sub> being preferably bromo, in the presence of a suitable solvent (for example dimethoxyethane, or the like), an inorganic base (for example sodium carbonate, or the like), and a palladium catalyst (for example 2-dicyclohexylphosphino-2',6'-dimethoxybiphenyl-palladium diacetate, or the like). The reaction takes place at about 90-125° C. and can take up to 20 minutes to 16 hours to complete.

Compounds of formula (I) can be prepared by proceeding as in the following Reaction Scheme IV:

89

Reaction Scheme IV:



in which Y, Y<sub>1</sub>, R<sub>2</sub>, R<sub>3</sub> and R<sub>4</sub> are as defined for formula (I) in the Summary of the Invention, and X<sub>3</sub> is a halogen, in particular chlorine and R a lower alkyl, in particular methyl.

Step 1: A compound of formula (Im) can be prepared by reacting a compound of formula (12) by reacting with an alkyl boroxine (for example methyl-boroxine, or the like) in the presence of a suitable solvent (for example dioxane, or the like), an inorganic base (for example potassium carbonate, or the like), and a palladium catalyst (for example tetrakis(triphenylphosphine)palladium(0), or the like). The reaction takes place at about 80° C. and can take up to 2 hours to complete.

Detailed examples of the synthesis of compounds of formula (I) can be found in the Examples, *infra*.

#### Additional Processes for Making Compounds of the Invention

A compound of the invention can be prepared as a pharmaceutically acceptable acid addition salt by reacting the free base form of the compound with a pharmaceutically acceptable inorganic or organic acid. Alternatively, a pharmaceutically acceptable base addition salt of a compound of the invention can be prepared by reacting the free acid form of the compound with a pharmaceutically acceptable inorganic or organic base.

Compounds of the formula (I) can also be modified by appending appropriate functionalities to enhance selective biological properties. Modifications of this kind are known in the art and include those that increase penetration into a given biological system (e.g. blood, lymphatic system, central nervous system, testis), increase bioavailability, increase solubility to allow parenteral administration (e.g. injection, infusion), alter metabolism and/or alter the rate of secretion. Examples of this type of modifications include but are not limited to esterification, e.g. with polyethylene glycols, derivatisation with pivaloyloxy or fatty acid substituents, conversion to carbamates, hydroxylation of aromatic rings and heteroatom substitution in aromatic rings. Wherever compounds of the formula (I), and/or N-oxides, tautomers and/or (preferably pharmaceutically acceptable) salts thereof are mentioned, this comprises such modified formulae, while

90

preferably the molecules of the formula (I), their N-oxides, their tautomers and/or their salts are meant.

Alternatively, the salt forms of the compounds of the invention can be prepared using salts of the starting materials or intermediates. In view of the close relationship between the novel compounds of the formula (I) in free form and those in the form of their salts, including those salts that can be used as intermediates, for example in the purification or identification of the novel compounds, any reference to the compounds or a compound of the formula (I) hereinbefore and hereinafter is to be understood as referring to the compound in free form and/or also to one or more salts thereof, as appropriate and expedient, as well as to one or more solvates, e.g. hydrates.

Salts are formed, for example, as acid addition salts, preferably with organic or inorganic acids, from compounds of formula (I) with a basic nitrogen atom, especially the pharmaceutically acceptable salts. Suitable inorganic acids are, for example, halogen acids, such as hydrochloric acid, sulfuric acid, or phosphoric acid. Suitable organic acids are, for example, carboxylic, phosphonic, sulfonic or sulfamic acids, for example acetic acid, propionic acid, octanoic acid, decanoic acid, dodecanoic acid, glycolic acid, lactic acid, fumaric acid, succinic acid, malonic acid, adipic acid, pimelic acid, suberic acid, azelaic acid, malic acid, tartaric acid, citric acid, amino acids, such as glutamic acid or aspartic acid, maleic acid, hydroxymaleic acid, methylmaleic acid, cyclohexanecarboxylic acid, adamantanecarboxylic acid, benzoic acid, salicylic acid, 4-aminosalicylic acid, phthalic acid, phenylacetic acid, mandelic acid, cinnamic acid, methane- or ethane-sulfonic acid, 2-hydroxyethanesulfonic acid, ethane-1,2-disulfonic acid, benzenesulfonic acid, 4-toluenesulfonic acid, 2-naphthalenesulfonic acid, 1,5-naphthalene-disulfonic acid, 2- or 3-methylbenzenesulfonic acid, methylsulfuric acid, ethylsulfuric acid, dodecylsulfuric acid, N-cyclohexyl-sulfamic acid, N-methyl-, N-ethyl- or N-propyl-sulfamic acid, or other organic protonic acids, such as ascorbic acid. Salts can usually be converted to free compounds, e.g. by treating with suitable basic compounds, for example with alkali metal carbonates, alkali metal hydrogencarbonates, or alkali metal hydroxides, typically potassium carbonate or sodium hydroxide.

For isolation or purification purposes it is also possible to use pharmaceutically unacceptable salts, for example picrates or perchlorates. For therapeutic use, only pharmaceutically acceptable salts or free compounds are employed (where applicable in the form of pharmaceutical preparations), and these are therefore preferred.

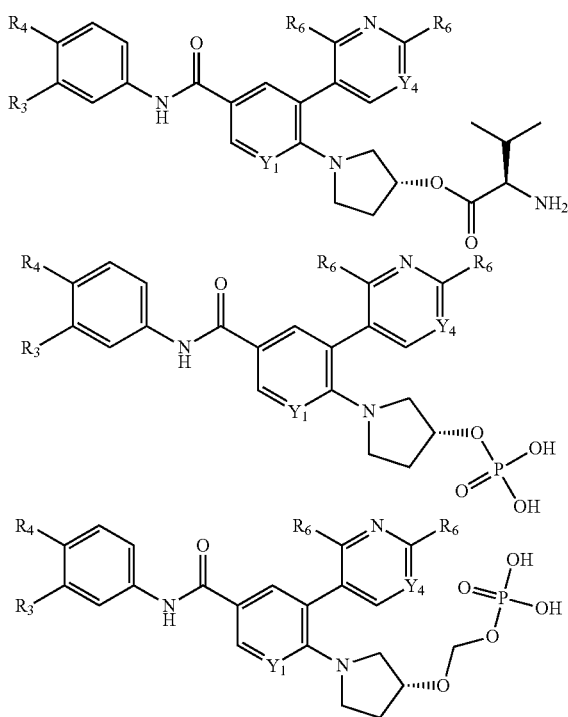
The free acid or free base forms of the compounds of the invention can be prepared from the corresponding base addition salt or acid addition salt from, respectively. For example a compound of the invention in an acid addition salt form can be converted to the corresponding free base by treating with a suitable base (e.g., ammonium hydroxide solution, sodium hydroxide, and the like). A compound of the invention in a base addition salt form can be converted to the corresponding free acid by treating with a suitable acid (e.g., hydrochloric acid, etc.).

Compounds of the invention in unoxidized form can be prepared from N-oxides of compounds of the invention by treating with a reducing agent (e.g., sulfur, sulfur dioxide, triphenyl phosphine, lithium borohydride, sodium borohy-

91

tride, phosphorus trichloride, tribromide, or the like) in a suitable inert organic solvent (e.g. acetonitrile, ethanol, aqueous dioxane, or the like) at 0 to 80° C.

Prodrug derivatives of the compounds of the invention can be prepared by methods known to those of ordinary skill in the art (e.g., for further details see Saulnier M G, Langley D R, Kadow J F, Senter P D, Knipe J O, Tun M M, Vyas D M and Doyle T W (1994) Synthesis of etoposide phosphate, BMY-4048 1: a watersoluble clinically active prodrug of etoposide. *Bioorg Med Chem Lett* 4:2567-2572; and Rautio J, Kumpulainen H, Heimbach T, Oliyai R, Oh D, Järvinen T and Savolainen J (2008). For example, a compound of the invention can form a prodrug as shown:



Protected derivatives of the compounds of the invention can be made by means known to those of ordinary skill in the art. If one or more other functional groups, for example carboxy, hydroxy, amino, sulfhydryl or the like are or need to be protected in a starting material as described herein or any other precursor, because they should not take part in the reaction or disturb the reaction, these are such groups as are usually used in the synthesis of peptide compounds, and also of cephalosporins and penicillins, as well as nucleic acid derivatives and sugars. Protecting groups are such groups that are no longer present in the final compounds once they are removed, while groups that remain as substituents are not protecting groups in the sense used here which are groups that are added at a starting material or intermediate stage and removed to obtain a final compound. Also in the case of conversions of a compound of the formula (I) into a different compound of the formula (I), protecting groups may be introduced and removed, if useful or required. The protecting groups may already be present in precursors and should protect the functional groups concerned against unwanted sec-

92

ondary reactions, such as acylations, etherifications, esterifications, oxidations, solvolysis, and similar reactions. It is a characteristic of protecting groups that they lend themselves readily, i.e. without undesired secondary reactions, to removal, typically by acetolysis, protonolysis, solvolysis, reduction, photolysis or also by enzyme activity, for example under conditions analogous to physiological conditions, and that they are not present in the end-products. The specialist knows, or can easily establish, which protecting groups are suitable with the reactions mentioned above and below.

The protection of such functional groups by such protecting groups, the protecting groups themselves, and their removal reactions are described for example in standard reference works, such as J. F. W. McOmie, "Protective Groups in Organic Chemistry", Plenum Press, London and New York 1973, in T. W. Greene, "Protective Groups in Organic Synthesis", Third edition, Wiley, New York 1999, in "The Peptides"; Volume 3 (editors: E. Gross and J. Meienhofer), Academic Press, London and New York 1981, in "Methoden der organischen Chemie" (*Methods of organic chemistry*), Houben Weyl, 4th edition, Volume 15/I, Georg Thieme Verlag, Stuttgart 1974, in H.-D. Jakubke and H. Jeschkeit, "Aminosäuren, Peptide, Proteine" (*Amino acids, peptides, proteins*), Verlag Chemie, Weinheim, Deerfield Beach, and Basel 1982, and in Jochen Lehmann, "Chemie der Kohlenhydrate: Monosaccharide and Derivate" (*Chemistry of carbohydrates: monosaccharides and derivatives*), Georg Thieme Verlag, Stuttgart 1974.

Compounds of the present invention can be conveniently prepared, or formed during the process of the invention, as solvates (e.g., hydrates). Hydrates of compounds of the present invention can be conveniently prepared by recrystallization from an aqueous/organic solvent mixture, using organic solvents such as dioxin, tetrahydrofuran or methanol.

Compounds of the invention can be prepared as their individual stereoisomers by reacting a racemic mixture of the compound with an optically active resolving agent to form a pair of diastereoisomeric compounds, separating the diastereomers and recovering the optically pure enantiomers. While resolution of enantiomers can be carried out using covalent diastereomeric derivatives of the compounds of the invention, dissociable complexes are preferred (e.g., crystalline diastereomeric salts). Diastereomers have distinct physical properties (e.g., melting points, boiling points, solubilities, reactivity, etc.) and can be readily separated by taking advantage of these dissimilarities. Diastereomeric mixtures for example may be separated into their individual diastereomers by means of fractionated crystallization, chromatography, solvent distribution, and similar procedures. This separation may take place either at the level of a starting compound or in a compound of formula (I) itself. Enantiomers may be separated through the formation of diastereomeric salts, for example by salt formation with an enantiomer-pure chiral acid, or by means of chromatography, for example by HPLC, using chromatographic substrates with chiral ligands. The optically pure enantiomer is then recovered, along with the resolving agent, by any practical means that would not result in racemization. A more detailed description of the techniques applicable to the resolution of stereoisomers of compounds from their racemic mixture can

be found in Jean Jacques, Andre Collet, Samuel H. Wilen, "Enantiomers, Racemates and Resolutions", John Wiley And Sons, Inc., 1981.

In summary, the compounds of formula (I) can be made by a process, which involves:

- (a) those of reaction schemes I-IV; and
- (b) optionally converting a compound of the invention into a pharmaceutically acceptable salt;
- (c) optionally converting a salt form of a compound of the invention to a non-salt form;
- (d) optionally converting an unoxidized form of a compound of the invention into a pharmaceutically acceptable N-oxide;
- (e) optionally converting an N-oxide form of a compound of the invention to its unoxidized form;
- (f) optionally resolving an individual isomer of a compound of the invention from a mixture of isomers;
- (g) optionally converting a non-derivatized compound of the invention into a pharmaceutically acceptable pro-drug derivative; and
- (h) optionally converting a prodrug derivative of a compound of the invention to its non-derivatized form.

Insofar as the production of the starting materials is not particularly described, the compounds are known or can be prepared analogously to methods known in the art or as disclosed in the Examples hereinafter.

One of skill in the art will appreciate that the above transformations are only representative of methods for preparation of the compounds of the present invention, and that other well known methods can similarly be used.

### EXAMPLES

The following examples illustrate the invention without limiting the scope thereof. In the examples provided, temperatures are given in degrees Celsius. Unless otherwise indicated, the reactions take place at room temperature. Further, if not indicated otherwise, the analytical HPLC conditions are as follows:

#### Condition 1:

UPLC-MS, column Acquity BEH C18, 1.7  $\mu$ m, 2.1 $\times$ 50 mm, oven at 40° C., eluents: A=water+0.1% formic acid and B=MeCN+0.1% formic acid, gradient from 20% to 100% B in 4.3 min, flow 0.7 mL/min, detection UV/VIS (DAD), ESI (+/-).

#### Condition 2:

LC-MS, column Ascentis® Express C18 2.7  $\mu$ m 2.1 $\times$ 30 mm, 50° C., eluents: A=water+0.05% formic acid+3.75 mM ammonium acetate and B=MeCN+0.04% formic acid, gradient from 5% to 95% B in 3.7 min, flow 1.2 mL/min to 1.4 mL/min in 3.7 min, detection UV/VIS (DAD), ESI (+/-).

#### Condition 3:

UPLC-MS, column Acquity HSS T3, 1.8  $\mu$ m, 2.1 $\times$ 50 mm, oven at 50° C., eluents: A=water+0.05% formic acid+3.75 mM ammonium acetate and B=MeCN+0.04% formic acid, gradient from 2% to 98% B in 1.40 min, then 98% B for 0.75 min, flow 1.2 mL/min, detection UV/VIS (DAD), ESI (+/-).

#### Condition 4:

HPLC, column Chromolith® Performance, RP-18e, 100 $\times$ 4.6 mm+precolum 5 $\times$ 4.6 mm at RT, eluents: A=water+0.1% formic acid and B=MeCN+0.1% formic acid, gradient from

2% to 100% B in 8 min, then 100% B for 2 min, flow 2.0 mL/min, detection UV/VIS (DAD).

#### Condition 5:

LC-MS, column Ascentis® Express C18 2.7  $\mu$ m 2.1 $\times$ 30 mm, 50° C., eluents: A=water+0.05% formic acid+3.75 mM ammonium acetate, and B=MeCN+0.04% formic acid, gradient from 10% to 95% B in 3.0 min, then 95% B for 1.0 min, flow 1.2 mL/min, detection UV/VIS (DAD), ESI (+/-).

#### Condition 6:

LC-MS, column Ascentis® Express C18 2.7  $\mu$ m 2.1 $\times$ 30 mm, 50° C., eluents: A=water+0.05% TFA, and B=MeCN+0.04% TFA, gradient from 10% to 95% B in 3.0 min, then 95% B for 1.0 min, flow 1.2 mL/min, detection UV/VIS (DAD), ESI (+).

#### Condition 7:

UPLC-MS, direct injection, detection UV/VIS (DAD), ESI (+/-).

#### Condition 8:

UPLC-MS, column Acquity BEH C18, 1.7  $\mu$ m, 2.1 $\times$ 50 mm, oven at 40° C., eluents: A=water+0.1% formic acid and B=MeCN+0.1% formic acid, gradient from 5% to 100% B in 2.0 min, flow 0.7 mL/min, detection UV/VIS (DAD), ESI (+/-).

#### Condition 9:

UPLC-MS, column Acquity UPLC BEH C8 1.7  $\mu$ m 2.1 $\times$ 50 mm, oven at 45° C., eluents: A=water+0.1% TFA and B=MeCN, gradient from 2% to 95% B in 2.8 min, then 95% B for 0.5 min, flow 0.8 mL/min, detection UV/VIS (DAD), ESI (+).

#### Condition 10:

HPLC, column CC125/4 Nucleosil® 100-3 C18HD, 4.0 $\times$ 125 mm, eluents: A=water+0.1% TFA and B=MeCN+0.1% TFA, gradient from 2% to 100% B in 7 min, then 100% B for 2 min and finally 100% to 2% B in 1 min, flow 1.0 mL/min, detection UV 215 nm.

#### Condition 11:

similar condition as Condition 3, oven at 60° C. instead of 50° C.

Further, if not indicated otherwise, the preparative HPLC conditions are as follows:

#### Condition 12:

Preparative HPLC, Column: XBridge C18 30 $\times$ 100 mm, 5  $\mu$ m; flow rate 30 mL/min; mobile phase: A=water+0.1% formic acid; B=MeCN; variable gradient, from initial % B to final % B, and runtime as specified in the Examples.

#### Condition 13:

Preparative HPLC, SunFire™ dc18 30 $\times$ 100 mm, 5  $\mu$ m; flow rate 30 mL/min; mobile phase: A=water+0.1% formic acid; B=MeCN; variable gradient, from initial % B to final % B, and runtime as specified in the Examples.

#### Condition 14:

Preparative HPLC Gilson system, column SunFire™ prep C18 OBD, 5  $\mu$ m 30 $\times$ 100 mm, eluents: A=water+0.1% TFA and B=MeCN, gradient 5% B for 2 min, then 5% to 100% B in 20 min and finally 100% B in 3 min, flow 30 mL/min, detection UV/VIS.

Preparative achiral SFC is done using the following system: Waters SFC THAR100; flow rate 100 mL/min; mobile phase: A=supercritical CO<sub>2</sub>; B=MeOH; variable gradient, from initial % B to final % B runtime and columns as specified in the Examples. Details for the columns:

95

Column 2-EP: column 2-Ethylpyridine (250×30 mm, 5 μm, 60 Å), Princeton

Column DEAP: column Diethyl amino (250×30 mm, 5 μm, 60 Å), Princeton

Column NH<sub>2</sub>: column Amino Reprosil 70 NH<sub>2</sub> (250×30 mm, 5 μm), Dr Maisch

Column Diol: column Diol (250×30 mm, 5 μm, 60 Å), Princeton

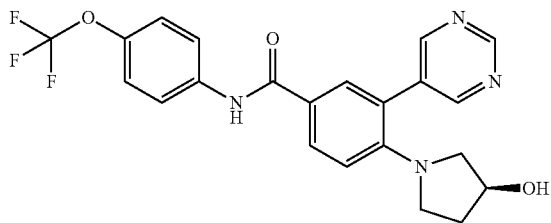
Column Silica: column silica (250×30 mm, 5 μm, 60 Å), Princeton

<sup>1</sup>H-NMR spectra were recorded on a 300 MHz, or a 400 MHz, or a 600 MHz NMR spectrometer as indicated. Significant peaks are tabulated in the order: multiplicity (s, singlet; d, doublet; t, triplet; q, quartet; m, multiplet; br. s, broad singlet) and number of protons.

In the following Examples, the abbreviations given below are used: aq. (aqueous); DAD (diode array detector); dba (dibenzylideneacetone); DCM (dichloromethane); DIPEA (diisopropyl-ethylamine); DMF (N,N-dimethylformamide); DME (dimethoxyethane); DMSO (dimethyl sulfoxide); dppf (1,1'-bis(diphenylphosphino)ferrocene); eq. (equivalents); ESI (electrospray ionization); EtOAc (ethyl acetate); EtOH (ethanol); Et<sub>2</sub>O (diethyl ether); h (hour); HPLC (high performance liquid chromatography); HV (high vacuum); iPrOH (isopropanol); iPr<sub>2</sub>O (diisopropyl ether); LC (liquid chromatography); M (molar); MeCN (acetonitrile); MeOH (methanol); min (minutes); mL (milliliters); MP (macroporous); MPLC (medium pressure liquid chromatography); MS (mass spectrometry); MW (microwave); n-BuLi (n-butyllithium); NMP (N-methylpyrrolidinone); NMR (nuclear magnetic resonance); PL (polystyrene); PPh<sub>3</sub> (triphenylphosphine); RM (reaction mixture); RT (room temperature); sat. (saturated); sec (seconds); SFC (supercritical fluid chromatography); Si-Thiol (3-mercaptopropyl modified silica gel) SPE (solid phase extraction); SPhos (2-dicyclohexylphosphino-2',6'-dimethoxybiphenyl); TBME (methyl tert-butyl ether); TFA (trifluoroacetic acid); TEA (triethylamine); THF (tetrahydrofuran); t<sub>R</sub> (retention time); UPLC (ultra performance liquid chromatography) and UV (Ultraviolet).

### Example 1

(S)-4-(3-Hydroxypyrrolidin-1-yl)-3-(pyrimidin-5-yl)-N-(4-(trifluoromethoxy)phenyl)benzamide

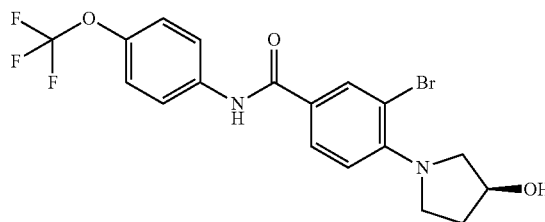


(S)-3-Bromo-4-(3-hydroxypyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)benzamide (Stage 1.1, 80 mg, 0.180 mmol), pyrimidin-5-ylboronic acid (66.8 mg, 0.539 mmol), Pd(PPh<sub>3</sub>)<sub>2</sub>Cl<sub>2</sub> (7.57 mg, 10.78 μmol) and Na<sub>2</sub>CO<sub>3</sub> (57.1 mg, 0.539 mmol) were added to a MW vial and was treated with a mixture of DME (762 μL), water (218 μL) and EtOH (109

96

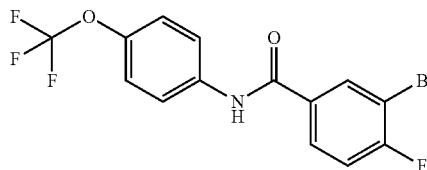
μL). The vial was sealed, evacuated/purged with argon and the RM was subjected to MW irradiation at 80° C. for 2 h. The RM was cooled to RT, diluted with THF (1 mL) and treated with Si-Thiol (Silicycle, 1.27 mmol/g, 70.7 mg, 0.090 mmol), filtered and the filtrate was evaporated off under reduced pressure to give a residue which, filtered and the filtrate was evaporated off under reduced pressure to give a residue which was purified by flash chromatography (RediSep® Silica gel column, 4 g, cyclohexane/EtOAc-EtOH+0.1% NH<sub>4</sub>OH (8:2), from 30% to 80% EtOAc-EtOH+0.1% NH<sub>4</sub>OH (8:2) to yield the title compound as a yellow solid. UPLC-MS (condition 1) t<sub>R</sub> 2.36 min, m/z=445.0 [M+H]<sup>+</sup>, m/z=443.1 [M-H]<sup>-</sup>; <sup>1</sup>H-NMR (400 MHz, DMSO-d<sub>6</sub>) δ ppm 1.70-1.80 (m, 1H) 1.82-1.94 (m, 1H) 2.68 (dd, 1H) 2.99-3.09 (m, 2H) 3.18-3.26 (m, 1H) 4.17-4.24 (m, 1H) 4.87 (d, J=3.67 Hz, 1H) 6.98 (d, J=8.80 Hz, 1H) 7.33 (d, J=8.31 Hz, 2H) 7.82-7.88 (m, 3H) 7.94 (dd, J=8.80, 2.45 Hz, 1H) 8.86 (s, 2H) 9.16 (s, 1H) 10.09 (s, 1H).

Stage 1.1 (S)-3-Bromo-4-(3-hydroxypyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)-benzamide



A mixture of 3-bromo-4-fluoro-N-(4-(trifluoromethoxy)phenyl)benzamide (Stage 1.2, 100 mg, 0.264 mmol), (S)-pyrrolidin-3-ol (46.1 mg, 0.529 mmol) and TEA (147 μL, 1.058 mmol) in DMSO (200 μL) was stirred at 90° C. for 16 h. The RM was diluted with 30 mL of TBME/EtOAc (1:1), sequentially washed 5 times with 0.5 M HCl and brine then evaporated to dryness under reduced pressure. The crude product was purified by flash column chromatography (RediSep® Silica gel column, 12 g, cyclohexane/EtOAc-EtOH+0.1% NH<sub>4</sub>OH (9:1), from 10% to 50% EtOAc-EtOH+0.1% NH<sub>4</sub>OH (9:1)) to afford the title compound as a white solid. UPLC-MS (condition 1) t<sub>R</sub> 2.83 min, m/z=444.9 [M+H]<sup>+</sup>, m/z=443.0 [M-H]<sup>-</sup>; <sup>1</sup>H-NMR (400 MHz, DMSO-d<sub>6</sub>) δ ppm 1.79-1.92 (m, 1H) 1.91-2.04 (m, 1H) 3.27 (d, J=10.76 Hz, 1H) 3.34-3.45 (m, 1H) 3.67 (dd, 1H) 3.81 (dd, J=10.39, 4.77 Hz, 1H) 4.30-4.42 (m, 1H) 4.97 (d, J=3.42 Hz, 1H) 6.93 (d, J=8.80 Hz, 1H) 7.34 (d, J=8.56 Hz, 2H) 7.81-7.90 (m, 3H) 8.13 (d, J=2.20 Hz, 1H) 10.18 (s, 1H).

Stage 1.2 3-Bromo-4-fluoro-N-(4-(trifluoromethoxy)phenyl)-benzamide

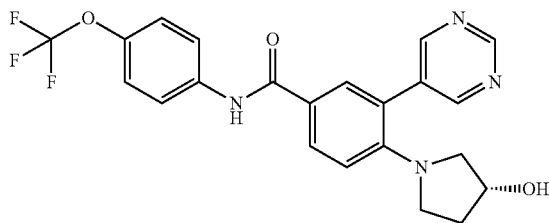


97

SOCI<sub>2</sub> (2.92 mL, 40.0 mmol) and DMF (0.5 mL) were added dropwise to a suspension of 3-bromo-4-fluorobenzoic acid (1.752 g, 8 mmol) in toluene (20 mL) and the RM was stirred at 80° C. for 1 h. The solvent was evaporated off under reduced pressure and the residue was diluted with THF (15 mL). DIPEA (2.79 mL, 16.00 mmol) was added and the mixture was cooled to 0° C., treated with a solution of 4-trifluoromethoxyaniline (1.181 mL, 8.80 mmol) in THF (5 mL) and stirred for 1 h. The RM was treated with aq. 1 M HCl (50 mL), and extracted with TBME. The combined extracts were washed with aq. 1 M HCl, aq. 1 M NaOH and brine, dried over MgSO<sub>4</sub> and the solvent was evaporated off under reduced pressure to give a residue was crystallized from n-heptane/DCM to afford the title compound as a white solid. UPLC-MS (Condition 1) t<sub>R</sub>=3.18 min, m/z=377.9/379.9 [M+H]<sup>+</sup>, m/z=375.9/377.9 [M-H]<sup>-</sup>; <sup>1</sup>H-NMR (400 MHz, DMSO-d<sub>6</sub>) δ ppm 7.38 (d, J=8.6 Hz, 2H) 7.56 (t, J=8.7 Hz, 1H) 7.87 (d, J=9.0 Hz, 2H) 8.00-8.06 (m, 1H) 8.32 (dd, J=6.6, 2.2 Hz, 1H) 10.50 (s, 1H).

## Example 2

(R)-4-(3-Hydroxypyrrolidin-1-yl)-3-(pyrimidin-5-yl)-N-(4-(trifluoromethoxy)phenyl)benzamide

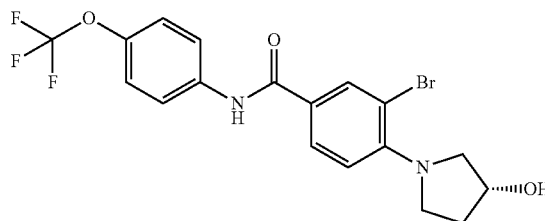


(R)-3-Bromo-4-(3-hydroxypyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)benzamide (Stage 2.1, 80 mg, 0.180 mmol), pyrimidin-5-ylboronic acid (66.8 mg, 0.539 mmol), Pd(PPh<sub>3</sub>)<sub>2</sub>Cl<sub>2</sub> (7.57 mg, 10.78 μmol) and Na<sub>2</sub>CO<sub>3</sub> (57.1 mg, 0.539 mmol) were added to a MW vial and treated with a mixture of DME (762 μL), water (218 μL) and EtOH (109 μL). The vial sealed, evacuated/purged with argon and then the RM was subjected to MW irradiation at 80° C. for 2 h. The RM was cooled to RT, diluted with THF (1 mL), treated with Si-Thiol (Silicycle, 1.27 mmol/g, 70.7 mg, 0.090 mmol), filtered and the filtrate was evaporated off under reduced pressure to give a residue which was purified by flash chromatography (RediSep® Silica gel column, 4 g, cyclohexane/EtOAc-EtOH+0.1% NH<sub>4</sub>OH (8:2), from 30% to 80% EtOAc-EtOH+0.1% NH<sub>4</sub>OH (8:2)) to yield the title compound as an off-white solid. UPLC-MS (condition 1) t<sub>R</sub>=2.37 min, m/z=445.0 [M+H]<sup>+</sup>, m/z=443.2 [M-H]<sup>-</sup>; <sup>1</sup>H-NMR (400 MHz, DMSO-d<sub>6</sub>) δ ppm 1.70-1.81 (m, 1H) 1.82-1.93 (m, 1H) 2.68 (dd, J=10.15, 1.10 Hz, 1H) 2.97-3.11 (m, 2H) 3.17-3.27 (m, 1H) 4.17-4.25 (m, 1H) 4.87 (d, J=3.67 Hz, 1H) 6.98 (d,

98

J=9.05 Hz, 1H) 7.33 (d, J=8.31 Hz, 2H) 7.79-7.90 (m, 3H) 7.94 (dd, J=8.80, 2.20 Hz, 1H) 8.86 (s, 2H) 9.16 (s, 1H) 10.09 (s, 1H).

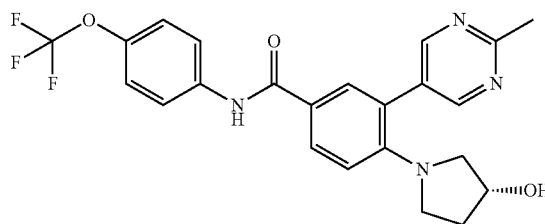
Stage 2.1 (R)-3-Bromo-4-(3-hydroxypyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)-benzamide



A mixture of 3-bromo-4-fluoro-N-(4-(trifluoromethoxy)phenyl)benzamide (Stage 1.2, 100 mg, 0.264 mmol), (R)-pyrrolidin-3-ol (46.1 mg, 0.529 mmol) and TEA (147 μL, 1.058 mmol) in DMSO (199 μL) was stirred at 90° C. for 16 h. The RM was diluted with TBME/EtOAc (1:1) (30 mL), washed with 0.5 M HCl (3×5 mL) and brine (5 mL) and the solvent was evaporated off under reduced pressure to give a crude product that was purified by flash chromatography (RediSep® Silica gel column, 4 g, cyclohexane/EtOAc-EtOH+0.1% NH<sub>4</sub>OH (8:2), from 30% to 80% EtOAc-EtOH+0.1% NH<sub>4</sub>OH (8:2)) to yield the title compound as an off-white solid. UPLC-MS (condition 1) t<sub>R</sub>=2.83 min, m/z=444.9/446.9 [M+H]<sup>+</sup>, m/z=443.0/445.0 [M-H]<sup>-</sup>; <sup>1</sup>H-NMR (400 MHz, DMSO-d<sub>6</sub>) δ ppm 1.80-1.92 (m, 1H) 1.92-2.04 (m, 1H) 3.24-3.30 (m, 1H) 3.36-3.46 (m, 1H) 3.60-3.72 (m, 1H) 3.81 (dd, J=10.51, 4.65 Hz, 1H) 4.36 (d, J=2.69 Hz, 1H) 4.97 (d, J=3.42 Hz, 1H) 6.93 (d, J=8.80 Hz, 1H) 7.34 (d, J=8.56 Hz, 2H) 7.80-7.90 (m, 3H) 8.14 (d, J=1.96 Hz, 1H) 10.19 (s, 1H).

## Example 3

(R)-4-(3-Hydroxypyrrolidin-1-yl)-3-(2-methylpyrimidin-5-yl)-N-(4-(trifluoromethoxy)phenyl)benzamide

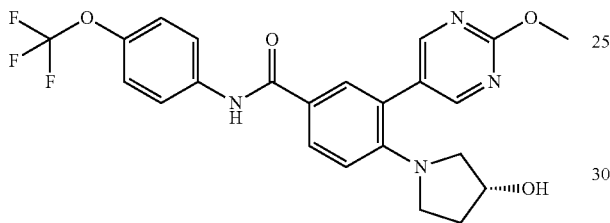


## 99

The title compound was prepared in an analogous fashion to that described in Example 1 using (R)-3-bromo-4-(3-hydroxypyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)benzamide (Stage 2.1) and 2-methyl-5-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)pyrimidine to afford a white solid. UPLC-MS (condition 1)  $t_R$ =2.46 min,  $m/z$ =459.1-460.1  $[M+H]^+$ ,  $m/z$ =457.2-458.2  $[M-H]^-$ ;  $^1H$ -NMR (400 MHz, DMSO- $d_6$ )  $\delta$  ppm 1.76 (d,  $J$ =3.91 Hz, 1H) 1.82-1.93 (m, 1H) 2.65-2.72 (m, 1H) 2.68 (s, 3H) 3.00-3.11 (m, 2H) 3.18-3.27 (m, 1H) 4.17-4.25 (m, 1H) 4.86 (d,  $J$ =3.67 Hz, 1H) 6.96 (d,  $J$ =8.80 Hz, 1H) 7.33 (d,  $J$ =8.56 Hz, 2H) 7.81 (d,  $J$ =2.20 Hz, 1H) 7.83-7.88 (m, 2H) 7.92 (dd,  $J$ =8.80, 2.20 Hz, 1H) 8.73 (s, 2H) 10.08 (s, 1H).

## Example 4

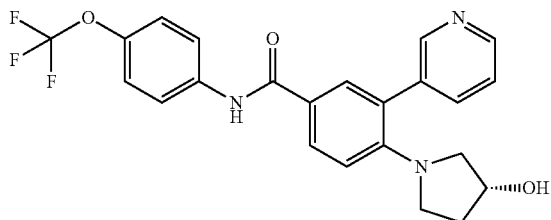
(R)-4-(3-Hydroxypyrrolidin-1-yl)-3-(2-methoxypyrimidin-5-yl)-N-(4-(trifluoromethoxy)phenyl)benzamide



The title compound was prepared in an analogous fashion to that described in Example 1 using (R)-3-bromo-4-(3-hydroxypyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)benzamide (Stage 2.1) and (6-methoxypyridin-3-yl)boronic acid to afford a white solid. LC-MS (Condition 2)  $t_R$ =1.96 min,  $m/z$ =475.2-476.2  $[M+H]^+$ ,  $m/z$ =573.1  $[M+TFA-H]^-$ ;  $^1H$ -NMR (400 MHz, DMSO- $d_6$ )  $\delta$  ppm 1.70-1.80 (m, 1H) 1.82-1.94 (m, 1H) 2.72 (d,  $J$ =9.29 Hz, 1H) 3.01-3.13 (m, 2H) 3.19-3.28 (m, 1H) 3.98 (s, 3H) 4.18-4.25 (m, 1H) 4.87 (d,  $J$ =3.42 Hz, 1H) 6.95 (d,  $J$ =8.80 Hz, 1H) 7.34 (d,  $J$ =8.80 Hz, 2H) 7.79 (d,  $J$ =1.96 Hz, 1H) 7.87 (d, 2H) 7.91 (dd,  $J$ =8.80, 2.20 Hz, 1H) 8.64 (s, 2H) 10.07 (s, 1H).

## Example 5

(R)-4-(3-Hydroxypyrrolidin-1-yl)-3-(pyridin-3-yl)-N-(4-(trifluoromethoxy)phenyl)benzamide



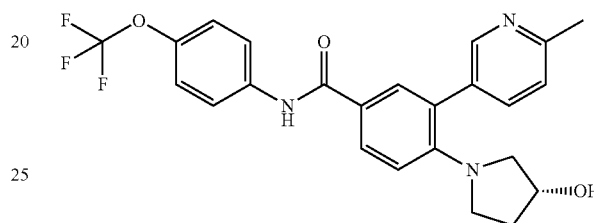
The title compound was prepared in analogous fashion to that described in Example 1 using (R)-3-bromo-4-(3-hydroxypyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)ben-

## 100

zamide (Stage 2.1) and pyridin-3-ylboronic acid to afford a white solid. UPLC-MS (condition 1)  $t_R$ =1.94 min,  $m/z$ =444.1  $[M+H]^+$ ,  $m/z$ =442.1  $[M-H]^-$ ;  $^1H$ -NMR (400 MHz, DMSO- $d_6$ )  $\delta$  ppm 1.68-1.79 (m, 1H) 1.85 (dt,  $J$ =8.62, 4.37 Hz, 1H) 2.66 (d,  $J$ =9.78 Hz, 1H) 2.98-3.07 (m, 2H) 3.16-3.25 (m, 1H) 4.18 (br. s, 1H) 4.84 (br. s, 1H) 6.95 (d,  $J$ =8.80 Hz, 1H) 7.33 (d,  $J$ =8.56 Hz, 2H) 7.50 (dd,  $J$ =7.82, 4.89 Hz, 1H) 7.80 (d,  $J$ =2.20 Hz, 1H) 7.81-7.89 (m, 3H) 7.92 (dd,  $J$ =8.68, 2.32 Hz, 1H) 8.56 (d,  $J$ =3.91 Hz, 1H) 8.65 (br. s, 1H) 10.10 (s, 1H).

## Example 6

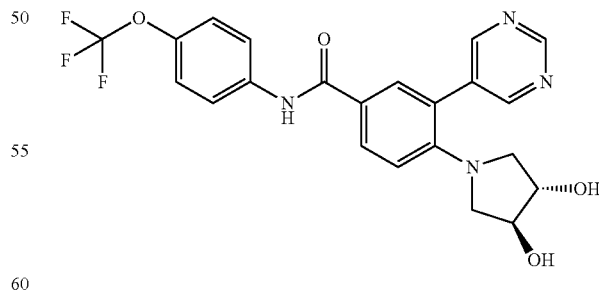
(R)-4-(3-Hydroxypyrrolidin-1-yl)-3-(6-methylpyridin-3-yl)-N-(4-(trifluoromethoxy)phenyl)benzamide



The title compound was prepared in an analogous fashion to that described in Example 1 using (R)-3-bromo-4-(3-hydroxypyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)benzamide (Stage 2.1) and (6-methylpyridin-3-yl)boronic acid to afford a white solid. UPLC-MS (condition 1)  $t_R$ =1.92,  $m/z$ =458.1-459.1  $[M+H]^+$ ,  $m/z$ =456.2-457.3  $[M-H]^-$ ;  $^1H$ -NMR (400 MHz, DMSO- $d_6$ )  $\delta$  ppm 1.69-1.78 (m, 1H) 1.81-1.91 (m, 1H) 2.53 (s, 3H) 2.67 (d,  $J$ =10.27 Hz, 1H) 3.00-3.08 (m, 2H) 3.18-3.28 (m, 1H) 4.16-4.21 (m, 1H) 4.83 (d,  $J$ =3.42 Hz, 1H) 6.93 (d,  $J$ =9.05 Hz, 1H) 7.30-7.36 (m, 3H) 7.68 (dd,  $J$ =7.95, 2.32 Hz, 1H) 7.77 (d,  $J$ =2.20 Hz, 1H) 7.84-7.92 (m, 3H) 8.48 (d,  $J$ =1.96 Hz, 1H) 10.09 (s, 1H).

## Example 7

4-((3S,4S)-3,4-Dihydroxypyrrolidin-1-yl)-3-(pyrimidin-5-yl)-N-(4-(trifluoromethoxy)phenyl)benzamide

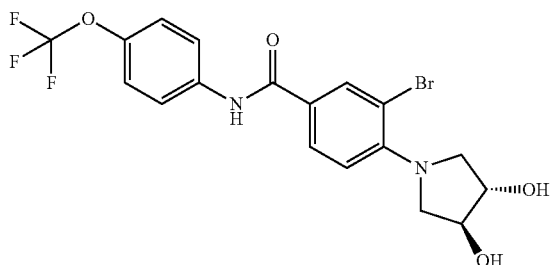


3-Bromo-4-((3S,4S)-3,4-dihydroxypyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)benzamide (Stage 7.1, 60 mg, 0.13 mmol), pyrimidin-5-ylboronic acid (66.6 mg, 0.325 mmol), Pd(PPh<sub>3</sub>)<sub>2</sub>Cl<sub>2</sub> (9.13 mg, 0.013 mmol) and Na<sub>2</sub>CO<sub>3</sub> (68.9 mg, 0.650 mmol) were added to a MW vial. The vial was sealed, evacuated/purged with argon, and DME (552  $\mu$ L), water (158

## 101

$\mu\text{L}$ ), EtOH (79  $\mu\text{L}$ ) were added. The RM was then subjected to MW irradiation at 120° C. for 10 min. The RM was diluted with DME (2 mL), treated with Si-Thiol (Silicycle, 1.27 mmol/g, 102 mg, 0.130 mmol), filtered and the filtrate was evaporated off under reduced pressure to give a residue which was purified by preparative HPLC (Condition 12, from 20% to 50% in 18 min) to yield the title compound as a white solid. UPLC-MS (condition 1)  $t_R$ =2.10 min,  $m/z$ =461.0  $[\text{M}+\text{H}]^+$ ,  $m/z$ =459.0  $[\text{M}-\text{H}]^-$ ;  $^1\text{H-NMR}$  (400 MHz, DMSO- $d_6$ )  $\delta$  ppm 2.75 (d,  $J$ =10.27 Hz, 2H) 3.27 (dd,  $J$ =10.39, 3.55 Hz, 2H) 3.88 (br. s, 2H) 5.07 (d,  $J$ =3.42 Hz, 2H) 6.97 (d,  $J$ =8.80 Hz, 1H) 7.34 (d,  $J$ =8.31 Hz, 2H) 7.82-7.90 (m, 3H) 7.94 (dd,  $J$ =8.80, 2.45 Hz, 1H) 8.85 (s, 2H) 9.17 (s, 1H) 10.10 (s, 1H).

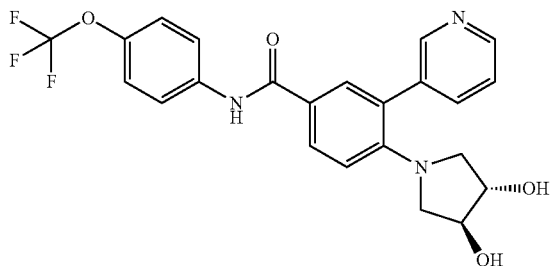
Stage 7.1 3-Bromo-4-((3S,4S)-3,4-dihydroxypyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)-benzamide



A solution of 3-bromo-4-fluoro-N-(4-(trifluoromethoxy)phenyl)benzamide (Stage 1.2, 500 mg, 1.322 mmol), (3S, 4S)-pyrrolidine-3,4-diol (205 mg, 1.984 mmol) and TEA (553  $\mu\text{L}$ , 3.97 mmol) in DMSO (994  $\mu\text{L}$ ) was stirred at 90° C. for 24 h. Additional (3S,4S)-pyrrolidine-3,4-diol, (68.2 mg, 0.661 mmol) and TEA (183  $\mu\text{L}$ , 1.322 mmol) were added and mixture was stirred at 100° C. for 16 h. The cooled treated with 0.5 M HCl (20 mL) and extracted with TBME/EtOAc (1:1). The combined extracts were washed with 0.5 M HCl (20 mL) and brine, dried over  $\text{MgSO}_4$  and the solvent was evaporated off under reduced pressure to give a residue which was crystallised from cyclohexane/EtOAc to afford the title compound as an off-white solid. UPLC-MS (condition 1)  $t_R$ =2.41 min,  $m/z$ =460.9/462.9  $[\text{M}+\text{H}]^+$ ,  $m/z$ =459.0/461.0  $[\text{M}-\text{H}]^-$ ;  $^1\text{H-NMR}$  (400 MHz, DMSO- $d_6$ )  $\delta$  ppm 3.24 (d,  $J$ =10.76 Hz, 2H) 3.88 (dd,  $J$ =10.51, 3.67 Hz, 2H) 4.02 (br. s, 2H) 5.15 (d,  $J$ =3.18 Hz, 2H) 6.89 (d,  $J$ =8.80 Hz, 1H) 7.34 (d,  $J$ =8.31 Hz, 2H) 7.84 (dd,  $J$ =8.68, 2.08 Hz, 1H) 7.85-7.89 (m, 2H) 8.13 (d,  $J$ =2.20 Hz, 1H) 10.17 (s, 1H).

## Example 8

4-((3S,4S)-3,4-Dihydroxypyrrolidin-1-yl)-3-(pyridin-3-yl)-N-(4-(trifluoromethoxy)phenyl)benzamide

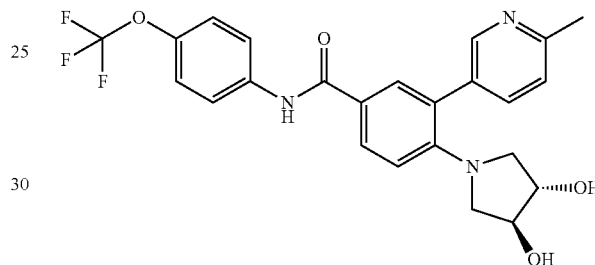


## 102

The title compound was prepared in an analogous fashion to that described in Example 7 using 3-bromo-4-((3S,4S)-3,4-dihydroxypyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)benzamide (Stage 7.1) and pyridin-3-ylboronic acid to afford a yellow solid. UPLC-MS (condition 1)  $t_R$ =1.67 min,  $m/z$ =460.0  $[\text{M}+\text{H}]^+$ ,  $m/z$ =458.0  $[\text{M}-\text{H}]^-$ ;  $^1\text{H-NMR}$  (400 MHz, DMSO- $d_6$ )  $\delta$  ppm 2.73 (d,  $J$ =10.76 Hz, 2H) 3.24 (dd,  $J$ =10.51, 3.67 Hz, 2H) 3.85 (d,  $J$ =2.20 Hz, 2H) 5.03 (br. s, 2H) 6.92 (d,  $J$ =8.80 Hz, 1H) 7.33 (d,  $J$ =8.31 Hz, 2H) 7.48 (dd,  $J$ =7.46, 5.26 Hz, 1H) 7.76-7.83 (m, 2H) 7.83-7.89 (m, 2H) 7.91 (dd,  $J$ =8.80, 2.20 Hz, 1H) 8.55 (dd,  $J$ =4.77, 1.59 Hz, 1H) 8.62 (d,  $J$ =1.47 Hz, 1H) 10.10 (s, 1H).

## Example 9

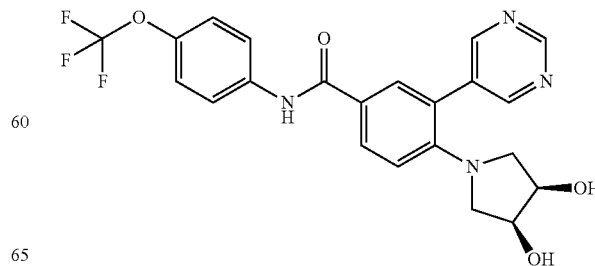
4-((3S,4S)-3,4-Dihydroxypyrrolidin-1-yl)-3-(6-methylpyridin-3-yl)-N-(4-(trifluoromethoxy)phenyl)benzamide



The title compound was prepared in an analogous fashion to that described in Example 7 using 3-bromo-4-((3S,4S)-3,4-dihydroxypyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)benzamide (Stage 7.1) and (6-methylpyridin-3-yl)boronic acid to afford a yellow solid. UPLC-MS (condition 1)  $t_R$ =1.65 min,  $m/z$ =474.0  $[\text{M}+\text{H}]^+$ ,  $m/z$ =472.1  $[\text{M}-\text{H}]^-$ ;  $^1\text{H-NMR}$  (400 MHz, DMSO- $d_6$ )  $\delta$  ppm 2.53 (s, 3H) 2.74 (d,  $J$ =10.76 Hz, 2H) 3.25 (dd,  $J$ =10.51, 3.67 Hz, 2H) 3.85 (br. s, 2H) 5.03 (br. s, 2H) 6.90 (d,  $J$ =8.80 Hz, 1H) 7.27-7.38 (m, 3H) 7.68 (dd,  $J$ =7.82, 2.20 Hz, 1H) 7.77 (d,  $J$ =2.20 Hz, 1H) 7.85-7.88 (m, 2H) 7.87-7.91 (m, 1H) 8.48 (d,  $J$ =2.20 Hz, 1H) 10.09 (s, 1H).

## Example 10

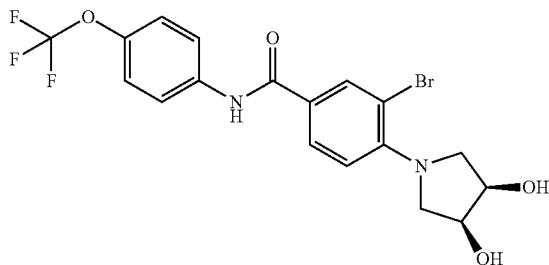
4-(cis-3,4-Dihydroxypyrrolidin-1-yl)-3-(pyrimidin-5-yl)-N-(4-(trifluoromethoxy)phenyl)benzamide



## 103

3-Bromo-4-((3S,4R)-3,4-dihydroxypyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)benzamide (Stage 10.1, 60 mg, 0.13 mmol), pyrimidin-5-ylboronic acid (32.2 mg, 0.260 mmol), Pd(PPh<sub>3</sub>)<sub>2</sub>Cl<sub>2</sub> (9.11 mg, 0.013 mmol) and Na<sub>2</sub>CO<sub>3</sub> (55.0 mg, 0.519 mmol) were added to a MW vial and treated with a mixture of DME (551  $\mu$ L), water (157  $\mu$ L) and EtOH (79  $\mu$ L). Vial was sealed, evacuated/purged with argon and subjected to MW irradiation at 125° C. for 10 min. The RM was diluted with DME (3 mL), treated with Si-Thiol (Silicycle, 1.44 mmol/g, 54.1 mg, 0.078 mmol), centrifuged, the supernatant was filtered and the solvent was evaporated off under reduced pressure to give a residue which was purified by preparative SFC (Column DEAP, isocratic 25% in 9 min.) to yield the title compound as a white solid. UPLC-MS (Condition 3)  $t_R$ =0.83 min,  $m/z$ =462.1 [M+H]<sup>+</sup>,  $m/z$ =460.1 [M-H]<sup>-</sup>; <sup>1</sup>H-NMR (400 MHz, DMSO-d<sub>6</sub>)  $\delta$  ppm 3.05 (dd, J=10.76, 4.16 Hz, 2H) 3.26 (dd, J=10.51, 4.89 Hz, 2H) 3.98 (t, J=3.91 Hz, 2H) 4.89 (br. s, 2H) 7.35 (d, J=8.56 Hz, 2H) 7.79-7.90 (m, 2H) 8.10 (d, J=2.20 Hz, 1H) 8.79 (d, J=2.20 Hz, 1H) 8.88 (s, 2H) 9.20 (s, 1H) 10.17 (s, 1H).

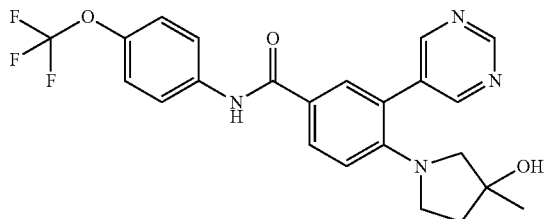
Stage 10.1 3-Bromo-4-((3S,4R)-3,4-dihydroxypyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)-benzamide



A solution of 3-bromo-4-fluoro-N-(4-(trifluoromethoxy)phenyl)benzamide (Stage 1.2, 500 mg, 1.32 mmol), (3S,4R)-pyrrolidine-3,4-diol (170 mg, 1.65 mmol) and TEA (369  $\mu$ L, 2.64 mmol) in DMSO (1322  $\mu$ L) was stirred at 90° C. for 20 h. The RM was treated with 0.5 M HCl (15 mL) and extracted with EtOAc (30 mL). The aq. phase was back-extracted with EtOAc (2x20 mL) and the combined organic layers were washed with sat. NaHCO<sub>3</sub> and brine, and dried over Na<sub>2</sub>SO<sub>4</sub>. The crude product was purified by flash chromatography (RediSep® Silica gel column, 40 g, cyclohexane/EtOAc, from 50% to 100% EtOAc) to yield the title compound as a white amorphous solid. UPLC-MS (Condition 3)  $t_R$ =1.02 min,  $m/z$ =461.2-463.1 [M+H]<sup>+</sup>,  $m/z$ =459.1-461.1 [M-H]<sup>-</sup>; <sup>1</sup>H-NMR (400 MHz, DMSO-d<sub>6</sub>)  $\delta$  ppm 3.40 (dd, J=9.90, 4.52 Hz, 2H) 3.67 (dd, J=9.66, 5.26 Hz, 2H) 4.06-4.16 (m, 2H) 4.94 (d, J=4.65 Hz, 2H) 6.86 (d, J=8.80 Hz, 1H) 7.34 (d, J=8.31 Hz, 2H) 7.80-7.91 (m, 3H) 8.13 (d, J=2.20 Hz, 1H) 10.17 (s, 1H).

## Example 11

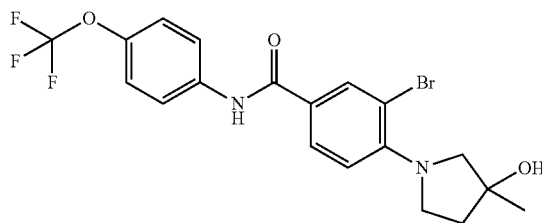
4-(3-Hydroxy-3-methylpyrrolidin-1-yl)-3-(pyrimidin-5-yl)-N-(4-(trifluoromethoxy)phenyl)benzamide



## 104

3-Bromo-4-(3-hydroxy-3-methylpyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)benzamide (Stage 11.1, 83 mg, 0.18 mmol), pyrimidin-5-ylboronic acid (66.9 mg, 0.540 mmol) and Na<sub>2</sub>CO<sub>3</sub> (57.2 mg, 0.540 mmol) were added to a MW vial and treated with a mixture of DME (764  $\mu$ L), water (218  $\mu$ L) and EtOH (109  $\mu$ L). The vial was sealed, evacuated/purged with argon and the RM was subjected to MW irradiation at 80° C. for 2 h. The RM was cooled to RT, diluted with THF (1 mL) and treated with Si-Thiol (Silicycle, 1.27 mmol/g, 70.9 mg, 0.090 mmol), filtered and the filtrate was evaporated off under reduced pressure to give a residue which was purified by flash chromatography (RediSep® Silica gel column, 4 g, cyclohexane/EtOAc-EtOH+0.1% NH<sub>4</sub>OH (8:2), from 20% to 70% EtOAc-EtOH+0.1% NH<sub>4</sub>OH (8:2)) to yield the title compound as a yellow solid. UPLC-MS (condition 1)  $t_R$ =2.47 min,  $m/z$ =459.0 [M+H]<sup>+</sup>,  $m/z$ =457.1 [M-H]<sup>-</sup>; <sup>1</sup>H-NMR (400 MHz, DMSO-d<sub>6</sub>)  $\delta$  ppm 1.19 (s, 3H) 1.68-1.83 (m, 2H) 2.77 (d, J=9.78 Hz, 1H) 2.87 (d, 1H) 2.97-3.07 (m, 1H) 3.21-3.30 (m, 1H) 4.72 (s, 1H) 6.96 (d, J=9.05 Hz, 1H) 7.33 (d, J=8.56 Hz, 2H) 7.80-7.89 (m, 3H) 7.94 (dd, J=8.93, 2.32 Hz, 1H) 8.86 (s, 2H) 9.16 (s, 1H) 10.09 (s, 1H), 9.29 ppm.

Stage 11.1 3-Bromo-4-(3-hydroxy-3-methylpyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)-benzamide

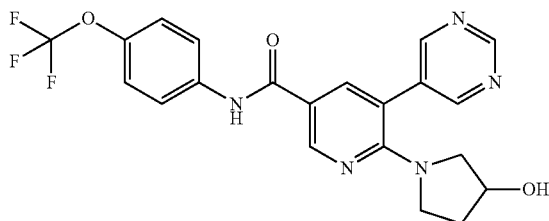


A mixture of 3-bromo-4-fluoro-N-(4-(trifluoromethoxy)phenyl)benzamide (Stage 1.2, 100 mg, 0.264 mmol), 3-methylpyrrolidine-3-ol hydrochloride (72.8 mg, 0.529 mmol), and TEA (147  $\mu$ L, 1.058 mmol) in DMSO (199  $\mu$ L) was stirred at 90° C. for 16 h. Additional TEA (73.7  $\mu$ L, 0.529 mmol) was added to the mixture and stirring was continued for 72 h at 100° C. The cooled RM was diluted with TBME/EtOAc (1:1)(30 mL), sequentially washed 0.5 M HCl (3x5 mL), brine (5 mL) and then evaporated to dryness under reduced pressure. The crude product was purified by flash chromatography (RediSep® Silica gel column, 12 g, cyclohexane/EtOAc-EtOH+0.1% NH<sub>4</sub>OH (9:1), from 20% to 60% EtOAc-EtOH+0.1% NH<sub>4</sub>OH (9:1)) to yield the title compound as a white solid. UPLC-MS (condition 1)  $t_R$ =2.98 min,  $m/z$ =459/461.0 [M+H]<sup>+</sup>,  $m/z$ =457/459 [M-H]<sup>-</sup>; <sup>1</sup>H-NMR (400 MHz, DMSO-d<sub>6</sub>)  $\delta$  ppm 1.35 (s, 3H) 1.77-1.95 (m, 2H) 3.32-3.35 (m, 1H) 3.37-3.48 (m, 1H) 3.65 (d, J=10.03 Hz, 1H) 3.75 (td, J=9.41, 7.09 Hz, 1H) 4.79 (s, 1H) 6.90 (d, J=8.80 Hz, 1H) 7.34 (d, J=8.31 Hz, 2H) 7.81-7.91 (m, 3H) 8.13 (d, J=1.96 Hz, 1H) 10.17 (s, 1H).

## 105

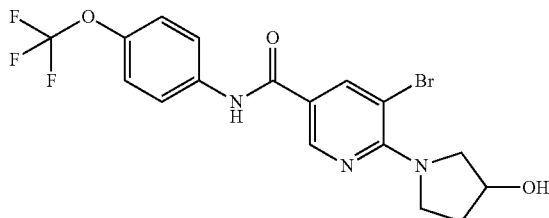
## Example 12

## 6-(3-Hydroxypyrrolidin-1-yl)-5-(pyrimidin-5-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide



5-Bromo-6-chloro-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 12.2, 60 mg, 0.152 mmol), (Rac.)-pyrrolidin-3-ol (15.86 mg, 0.182 mmol), and DIPEA (53.0  $\mu$ L, 0.303 mmol) in iPrOH (250  $\mu$ L) were added to a MW vial and subjected to MW irradiation at 110° C. for 20 min. The RM was then transferred into a MV vial containing pyrimidin-5-ylboronic acid (56.4 mg, 0.455 mmol), Pd(PPh<sub>3</sub>)<sub>2</sub>Cl<sub>2</sub> (10.65 mg, 0.015 mmol), Na<sub>2</sub>CO<sub>3</sub> (80 mg, 0.758 mmol) and treated with a mixture of DME (600  $\mu$ L)-water (200  $\mu$ L). The vial was sealed, evacuated/purged with argon and the RM was subjected to MW irradiation at 80° C. for 2 h. The RM was cooled to RT, diluted with THF (1.5 mL), treated with Si-Thiol (Silicycle, 59.7 mg, 0.076 mmol), filtered and the filtrate was evaporated off under reduced pressure to give a residue which was purified by preparative HPLC (Condition 13, 30% for 0.2 min then 30% to 60% in 12 min) to yield the title compound as a white solid. UPLC-MS (condition 1)  $t_R$ =2.01 min,  $m/z$ =446.0 [M+H]<sup>+</sup>,  $m/z$ =444.1 [M-H]<sup>-</sup>; <sup>1</sup>H-NMR (400 MHz, DMSO-d<sub>6</sub>)  $\delta$  ppm 1.70-1.79 (m, 1H) 1.79-1.90 (m, 1H) 2.88 (d, J=11.0 Hz, 1H) 3.18-3.27 (m, 2H) 3.38-3.43 (m, 1H) 4.17-4.25 (m, 1H) 4.79-5.01 (m, 1H) 7.35 (d, J=8.3 Hz, 2H) 7.85 (d, J=4.9 Hz, 2H) 8.10 (d, J=2.4 Hz, 1H) 8.79 (d, J=2.4 Hz, 1H) 8.89 (s, 2H) 9.19 (s, 1H) 10.18 (s, 1H).

## Stage 12.1 5-Bromo-6-(3-hydroxypyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide

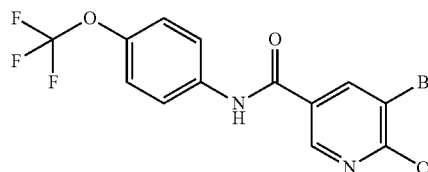


5-Bromo-6-chloro-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 12.2, 1 g, 2.53 mmol) and (Rac.)-pyrrolidin-3-ol (264 mg, 3.03 mmol) and DIPEA (883  $\mu$ L, 5.06 mmol), in iPrOH (4213  $\mu$ L) were added a MW vial and heated at 140°

## 106

C. for 30 min. The RM was evaporated to dryness under reduced pressure, treated with 0.5 M HCl (10 mL) and EtOAc (20 mL) and extracted with EtOAc. The combined extracts were washed with water, dried over MgSO<sub>4</sub> and evaporated to dryness under reduced pressure. Trituration of the residue in cyclohexane and filtration of the solid afforded the title compound as an off-white solid. UPLC-MS (condition 1)  $t_R$ =2.63 min,  $m/z$ =445.9-447.9 [M+H]<sup>+</sup>,  $m/z$ =444.0-446.0 [M-H]<sup>-</sup>; <sup>1</sup>H-NMR (400 MHz, DMSO-d<sub>6</sub>)  $\delta$  ppm 1.80-2.02 (m, 2H) 3.58 (d, J=11.49 Hz, 1H) 3.67-3.79 (m, 1H) 3.82-3.93 (m, 2H) 4.32-4.40 (m, 1H) 4.98 (br. s, 1H) 7.36 (d, J=8.56 Hz, 2H) 7.86 (d, J=9.05 Hz, 2H) 8.35 (d, J=1.96 Hz, 1H) 8.69 (d, J=1.96 Hz, 1H) 10.23 (s, 1H).

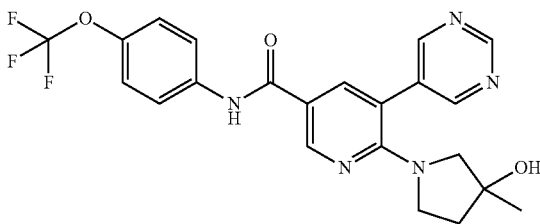
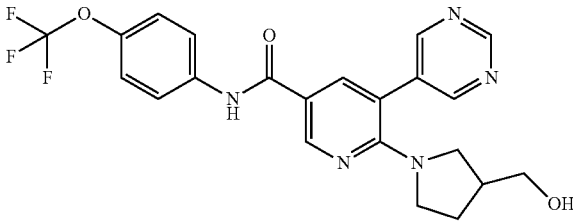
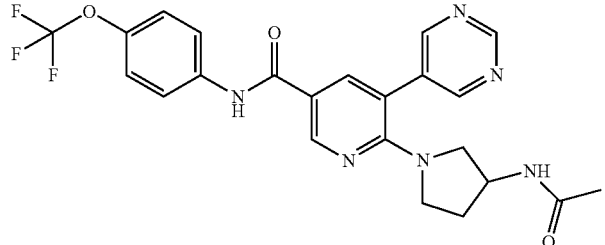
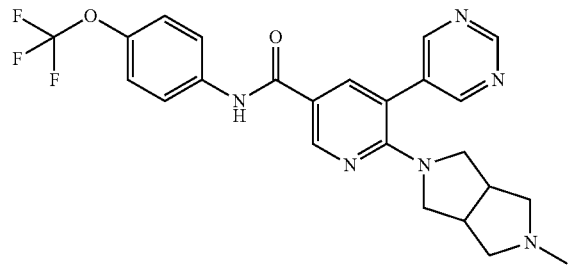
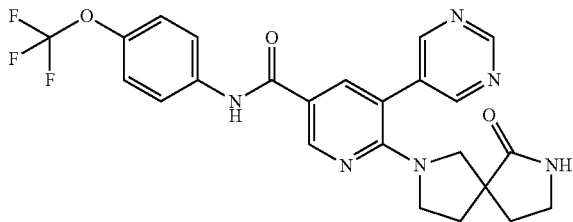
## Stage 12.2 5-Bromo-6-chloro-N-(4-(trifluoromethoxy)phenyl)nicotinamide



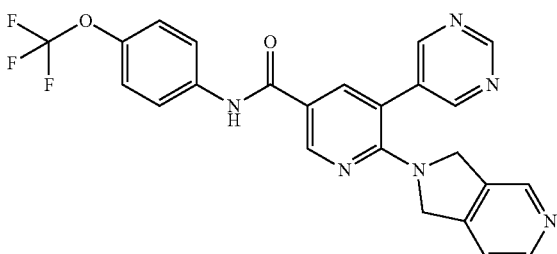
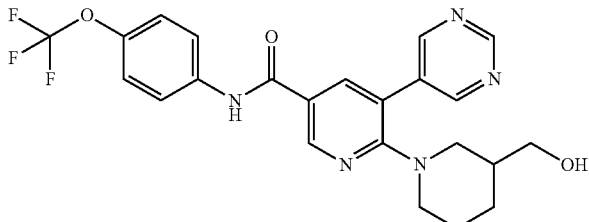
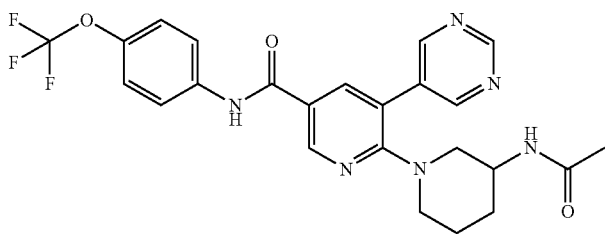
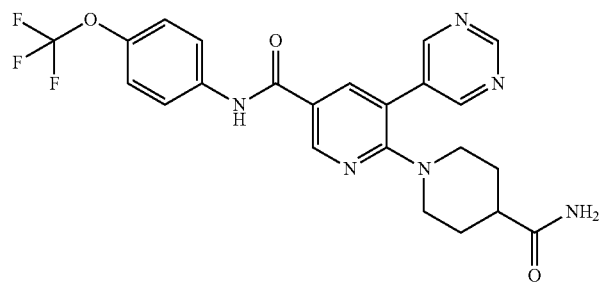
SOCI<sub>2</sub> (1.089 mL, 14.92 mmol) and DMF (0.01 mL) were added dropwise to a suspension of 5-bromo-6-chloronicotinic acid (1.176 g, 4.97 mmol) in toluene (10 mL) and the RM was stirred at 85° C. for 2 h. The solvent was evaporated off under reduced pressure and the residue was diluted with THF (10 mL). DIPEA (1.74 mL, 9.95 mmol) was added and the mixture was cooled to -15° C. under argon atmosphere, treated with a solution of 4-trifluoromethoxyaniline (0.701 mL, 5.22 mmol) in THF (10 mL) and stirred at RT for 1 h. The solvent was off under reduced pressure and the residue was treated with aq. 1M HCl (50 mL), and extracted with TBME/EtOAc (4:1). The combined extracts were washed with aq. 1 M HCl, sat. aq. Na<sub>2</sub>CO<sub>3</sub> and brine, dried over MgSO<sub>4</sub> and the solvent was evaporated off under reduced pressure to give the crude product was purified by flash chromatography (Biotage Silica gel column, 50 g, cyclohexane/EtOAc from 5% to 25% EtOAc) to afford the title compound as an off-white solid. UPLC-MS (Condition 1)  $t_R$ =3.09 min,  $m/z$ =394.9/396.8 [M+H]<sup>+</sup>,  $m/z$ =393.0/394.9 [M-H]<sup>-</sup>; <sup>1</sup>H-NMR (400 MHz, DMSO-d<sub>6</sub>)  $\delta$  ppm 7.40 (d, J=8.6 Hz, 2H) 7.86 (d, J=9.0 Hz, 2H) 8.73 (d, J=2.2 Hz, 1H) 8.92 (d, J=2.0 Hz, 1H) 10.69 (s, 1H).

## Example 13-27

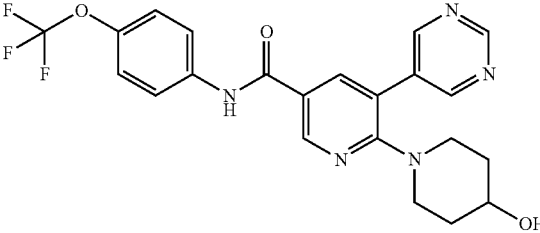
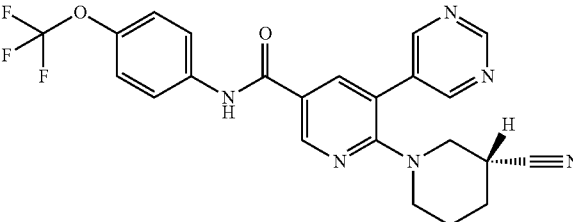
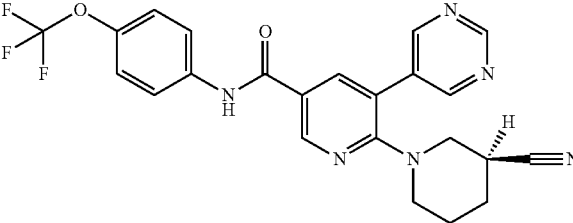
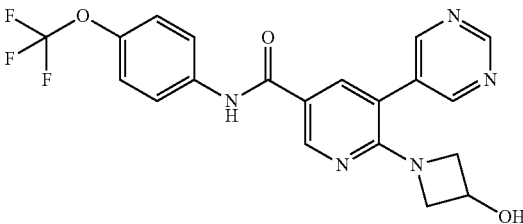
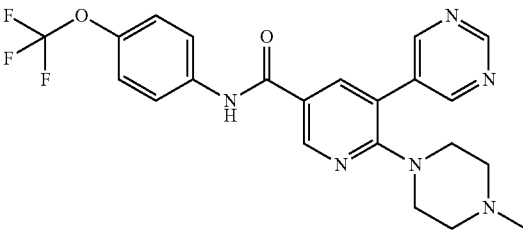
The following examples were prepared in an analogous fashion to that described in Example 12 using 5-bromo-6-(3-hydroxy-3-methylpyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 12.2) and starting material as indicated.

Ex.	Structure/Name	Starting material Analytics
13	 <p>6-(3-hydroxy-3-methylpyrrolidin-1-yl)-5-(pyrimidin-5-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide</p>	<p>3-methylpyrrolidin-3-ol hydrochloride</p> <p>UPLC-MS (condition 1) <math>t_R = 2.59</math> min, <math>m/z = 460.0</math> <math>[M + H]^+</math>, <math>m/z = 458.0</math> <math>[M - H]^-</math>; <math>^1H</math>-NMR (400 MHz, DMSO-<math>d_6</math>) <math>\delta</math> ppm 1.20 (s, 3 H) 1.65-1.85 (m, 2 H) 2.96 (d, 1 H) 3.03 (d, 1 H) 3.17-3.25 (m, 1 H) 3.44-3.47 (m, 1 H) 4.72 (br. s, 0 H) 7.35 (d, <math>J = 8.31</math> Hz, 2 H) 7.85 (d, <math>J = 4.65</math> Hz, 2 H) 8.09 (d, <math>J = 2.20</math> Hz, 1 H) 8.78 (d, <math>J = 2.20</math> Hz, 1 H) 8.89 (s, 2 H) 9.19 (s, 1 H) 10.16 (s, 1 H).</p>
14	 <p>6-(3-(hydroxymethyl)pyrrolidin-1-yl)-5-(pyrimidin-5-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide</p>	<p>pyrrolidin-3-ylmethanol</p> <p>UPLC-MS (Condition 9) <math>t_R = 1.57</math> min, <math>m/z = 460.4</math> <math>[M + H]^+</math>.</p>
15	 <p>6-(3-acetamidopyrrolidin-1-yl)-5-(pyrimidin-5-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide</p>	<p>N-(pyrrolidin-3-yl)acetamide</p> <p>UPLC-MS (Condition 9) <math>t_R = 1.63</math> min, <math>m/z = 487.4</math> <math>[M + H]^+</math>.</p>
16	 <p>6-(5-methylhexahydropyrrolo[3,4-c]pyrrol-2(1H)-yl)-5-(pyrimidin-5-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide</p>	<p>2-methyloctahydropyrrolo[3,4-c]pyrrole</p> <p>UPLC-MS (Condition 3) <math>t_R = 0.76</math> min, <math>m/z = 485.2</math> <math>[M + H]^+</math>, <math>483.1</math> <math>[M - H]^-</math>.</p>
17	 <p>6-(6-oxo-2,7-diazaspiro[4.4]nonan-1-yl)-5-(pyrimidin-5-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide</p>	<p>2,7-diazaspiro[4.4]nonan-1-one</p> <p>UPLC-MS (Condition 9) <math>t_R = 1.66</math> min, <math>m/z = 499.4</math> <math>[M + H]^+</math>.</p>

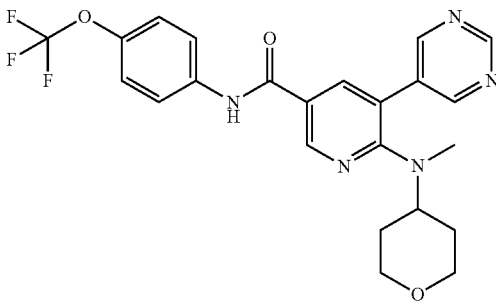
-continued

Ex.	Structure/Name	Starting material Analytics
18	 <p>5-(pyrimidin-5-yl)-6-(1H-pyrrolo[3,4-c]pyridin-2(3H)-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide</p>	<p>12/12 and 2,3-dihydro-1H-pyrrolo[3,4-c]pyridine</p> <p>UPLC-MS (Condition 9) <math>t_R = 1.60</math> min, <math>m/z = 479.4</math> <math>[M + H]^+</math>.</p>
19	 <p>6-(3-(hydroxymethyl)piperidin-1-yl)-5-(pyrimidin-5-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide</p>	<p>piperidin-3-ylmethanol</p> <p>UPLC-MS (Condition 9) <math>t_R = 1.82</math> min, <math>m/z = 474.4</math> <math>[M + H]^+</math>.</p>
20	 <p>6-(3-acetamidopiperidin-1-yl)-5-(pyrimidin-5-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide</p>	<p>N-(piperidin-3-yl)acetamide</p> <p>UPLC-MS (Condition 9) <math>t_R = 1.82</math> min, <math>m/z = 501.5</math> <math>[M + H]^+</math>.</p>
21	 <p>6-(4-carbamoylpiperidin-1-yl)-5-(pyrimidin-5-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide</p>	<p>piperidine-4-carboxamide</p> <p>UPLC-MS (Condition 9) <math>t_R = 1.73</math> min, <math>m/z = 487.5</math> <math>[M + H]^+</math>.</p>

-continued

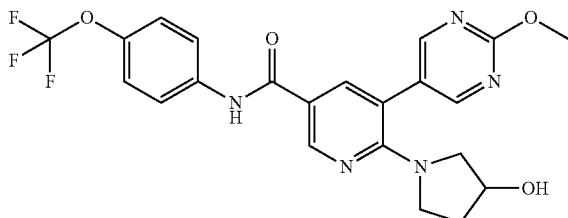
Ex.	Structure/Name	Starting material Analytics
22	 <p>6-(4-hydroxypiperidin-1-yl)-5-(pyrimidin-5-yl)- N-(4-(trifluoromethoxy)phenyl)nicotinamide</p>	<p>piperidin-4-ol UPLC-MS (Condition 9) <math>t_R = 1.75</math> min, <math>m/z = 460.4</math> <math>[M + H]^+</math>.</p>
23	 <p>(R)-6-(3-cyanopiperidin-1-yl)-5-(pyrimidin-5-yl)- N-(4-(trifluoromethoxy)phenyl)nicotinamide</p>	<p>(R)-piperidine-3-carbonitrile UPLC-MS (Condition 9) <math>t_R = 2.00</math> min, <math>m/z = 469.4</math> <math>[M + H]^+</math>.</p>
24	 <p>(S)-6-(3-cyanopiperidin-1-yl)-5-(pyrimidin-5-yl)- N-(4-(trifluoromethoxy)phenyl)nicotinamide</p>	<p>(S)-piperidine-3-carbonitrile UPLC-MS (Condition 9) <math>t_R = 2.00</math> min, <math>m/z = 469.4</math> <math>[M + H]^+</math>.</p>
25	 <p>6-(3-hydroxyazetidin-1-yl)-5-(pyrimidin-5-yl)-N- (4-(trifluoromethoxy)phenyl)nicotinamide</p>	<p>3-hydroazetidine hydrochloride UPLC-MS (condition 1) <math>t_R = 1.99</math> min, <math>m/z = 432.0</math> <math>[M + H]^+</math>, <math>m/z = 430.1</math> <math>[M - H]^-</math>; <math>^1H</math>-NMR (400 MHz, DMSO-<math>d_6</math>) <math>\delta</math> ppm 3.44-3.55 (m, 2 H) 3.85-3.98 (m, 2 H) 4.31-4.46 (m, 1 H) 5.59 (d, <math>J = 6.1</math> Hz, 1 H) 7.36 (d, <math>J = 8.6</math> Hz, 2 H) 7.85 (d, <math>J = 9.3</math> Hz, 2 H) 8.10 (d, <math>J = 2.2</math> Hz, 1 H) 8.80 (d, <math>J = 2.2</math> Hz, 1 H) 8.91 (s, 2 H) 9.22 (s, 1 H) 10.22 (s, 1 H).</p>
26	 <p>6-(4-methylpiperazin-1-yl)-5-(pyrimidin-5-yl)-N- (4-(trifluoromethoxy)phenyl)nicotinamide</p>	<p>1-methylpiperazine UPLC-MS (Condition 9) <math>t_R = 1.56</math> min, <math>m/z = 459.4</math> <math>[M + H]^+</math>.</p>

-continued

Ex.	Structure/Name	Starting material Analytics
27	 <p>6-(methyl(tetrahydro-2H-pyran-4-yl)amino)-5-(pyrimidin-5-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide</p>	<p>N-methyltetrahydro-2H-pyran-4-amine            UPLC-MS (Condition 9) <math>t_R = 1.94</math> min, <math>m/z = 474.4</math> <math>[M + H]^+</math>.</p>

## Example 28

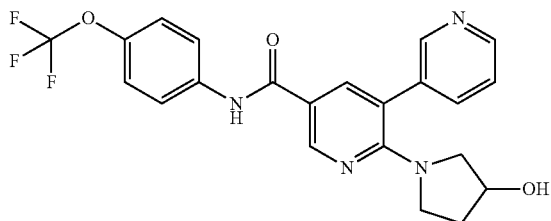
6-(3-Hydroxypyrrolidin-1-yl)-5-(2-methoxypyrimidin-5-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide



5-bromo-6-(3-hydroxypyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide (60 mg, 0.134 mmol), (6-methoxypyridin-3-yl)boronic acid (62.1 mg, 0.403 mmol),  $\text{Pd}(\text{PPh}_3)_2\text{Cl}_2$  (5.66 mg, 8.07  $\mu\text{mol}$ ) and  $\text{Na}_2\text{CO}_3$  (42.8 mg, 0.403 mmol) were added to a MW vial and treated with a mixture of DME (570  $\mu\text{L}$ ), water (163  $\mu\text{L}$ ) and EtOH (81  $\mu\text{L}$ ). The vial was sealed, evacuated/purged with argon and the RM was subjected to MW irradiation at 80° C. for 2 h. The RM was cooled to RT, diluted with THF (2 mL), treated with Si-Thiol (Silicycle, 1.27 mmol/g, 52.9 mg, 0.067 mmol), filtered and the filtrate was evaporated off under reduced pressure to give a residue which was purified by preparative HPLC (Condition 13, from 25% to 55% in 12 min) to afford the title compound as an off-white solid. UPLC-MS (condition 1)  $t_R = 2.19$  min,  $m/z = 473.0$   $[M + H]^+$ ,  $m/z = 474.1$   $[M - H]^-$ ;  $^1\text{H-NMR}$  (400 MHz,  $\text{DMSO-d}_6$ )  $\delta$  ppm 1.68-1.80 (m, 1H) 1.79-1.92 (m, 1H) 2.94 (d,  $J = 11.00$  Hz, 1H) 3.21-3.29 (m, 2H) 3.35-3.46 (m, 1H) 3.98 (s, 3H) 4.18-4.29 (m, 1H) 4.87 (br. s, 1H) 7.35 (d,  $J = 8.80$  Hz, 2H) 7.85 (d,  $J = 9.05$  Hz, 2H) 8.02 (d,  $J = 2.45$  Hz, 1H) 8.67 (s, 2H) 8.77 (d,  $J = 2.20$  Hz, 1H) 10.15 (s, 1H).

## Example 29

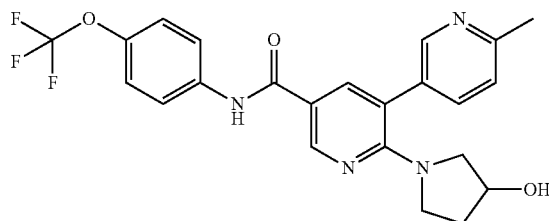
2-(3-Hydroxypyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)-[3,3'-bipyridine]-5-carboxamide



The title compound was prepared in an analogous fashion to that described in Example 28 using 5-bromo-6-(3-hydroxypyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 12.1) and pyridin-3-ylboronic acid to afford a white solid. UPLC-MS (condition 1)  $t_R = 1.78$  min,  $m/z = 445.0$   $[M + H]^+$ ,  $m/z = 443.1$   $[M - H]^-$ ;  $^1\text{H-NMR}$  (400 MHz,  $\text{DMSO-d}_6$ )  $\delta$  ppm 1.67-1.78 (m, 1H) 1.78-1.90 (m, 1H) 2.88 (d,  $J = 11.25$  Hz, 1H) 3.13-3.28 (m, 2H) 3.35-3.45 (m, 1H) 4.20 (br. s, 1H) 4.85 (d,  $J = 3.42$  Hz, 1H) 7.35 (d,  $J = 8.80$  Hz, 2H) 7.50 (dd,  $J = 7.82, 4.89$  Hz, 1H) 7.82 (d,  $J = 8.07$  Hz, 1H) 7.86 (d,  $J = 9.05$  Hz, 2H) 8.04 (d,  $J = 2.20$  Hz, 1H) 8.59 (dd,  $J = 4.77, 1.34$  Hz, 1H) 8.65 (d,  $J = 1.96$  Hz, 1H) 8.78 (d,  $J = 2.20$  Hz, 1H) 10.17 (s, 1H).

## Example 30

2-(3-Hydroxypyrrolidin-1-yl)-6'-methyl-N-(4-(trifluoromethoxy)phenyl)-[3,3'-bipyridine]-5-carboxamide

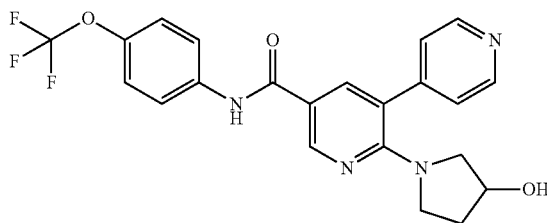


The title compound was prepared in an analogous fashion to that described in Example 28 using 5-bromo-6-(3-hydroxypyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 12.1) and (6-methylpyridin-3-yl)boronic acid to afford an off-white solid. UPLC-MS (condition 1)  $t_R = 1.61$  min,  $m/z = 459.0$   $[M + H]^+$ ,  $m/z = 457.2$   $[M - H]^-$ ;  $^1\text{H-NMR}$  (400 MHz,  $\text{DMSO-d}_6$ )  $\delta$  ppm 1.67-1.77 (m, 1H) 1.77-1.88 (m, 1H) 2.53 (s, 3H) 2.88 (d,  $J = 11.49$  Hz, 1H) 3.15-3.27 (m, 2H) 3.38 (td,  $J = 9.96, 7.21$  Hz, 1H) 4.15-4.22 (m, 1H) 4.84 (d,  $J = 3.42$  Hz, 1H) 7.34 (d,  $J = 8.07$  Hz, 3H) 7.68 (dd,  $J = 7.95, 2.32$  Hz, 1H) 7.85 (d,  $J = 9.05$  Hz, 2H) 7.99 (d,  $J = 2.45$  Hz, 1H) 8.48 (d,  $J = 2.20$  Hz, 1H) 8.75 (d,  $J = 2.45$  Hz, 1H) 10.15 (s, 1H).

## 115

## Example 31

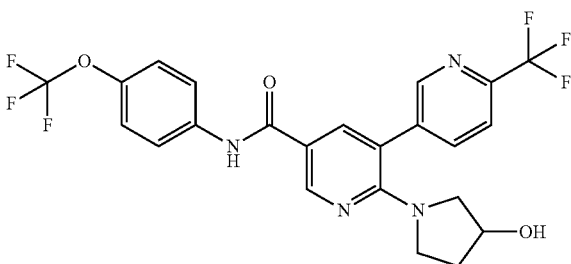
2-(3-Hydroxypyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)-[3,4'-bipyridine]-5-carboxamide



The title compound was prepared in an analogous fashion to that described in Example 28 using 5-bromo-6-(3-hydroxypyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 12.1) and 4-pyridineboronic acid to afford a yellow solid. UPLC-MS (condition 1)  $t_R=1.62$  min,  $m/z=445.0$   $[M+H]^+$ ,  $m/z=443.1$   $[M-H]^-$ ;  $^1H$ -NMR (400 MHz, DMSO- $d_6$ )  $\delta$  ppm 1.70-1.80 (m, 1H) 1.85 (dd,  $J=8.68$ , 4.28 Hz, 1H) 2.85 (d,  $J=11.49$  Hz, 1H) 3.24 (dd,  $J=11.25$ , 4.16 Hz, 2H) 3.40-3.53 (m, 1H) 4.21 (br. s, 1H) 4.87 (br. s, 1H) 7.35 (d,  $J=8.80$  Hz, 2H) 7.45 (d,  $J=5.87$  Hz, 2H) 7.86 (d,  $J=9.29$  Hz, 2H) 8.07 (d,  $J=2.45$  Hz, 1H) 8.65 (d,  $J=5.14$  Hz, 2H) 8.78 (d,  $J=2.20$  Hz, 1H) 10.21 (s, 1H).

## Example 32

2-(3-Hydroxypyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)-6'-(trifluoromethyl)-[3,3'-bipyridine]-5-carboxamide

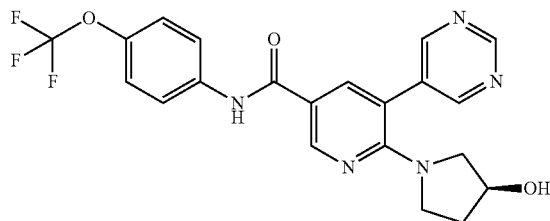


The title compound was prepared in an analogous fashion to that described in Example 28 using 5-bromo-6-(3-hydroxypyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 12.1) and (6-(trifluoromethyl)pyridin-3-yl)boronic acid to afford an off-white solid. UPLC-MS (condition 1)  $t_R=2.77$  min,  $m/z=513.0$   $[M+H]^+$ ,  $m/z=511.1$   $[M-H]^-$ ;  $^1H$ -NMR (400 MHz, DMSO- $d_6$ )  $\delta$  ppm 1.70-1.80 (m, 1H) 1.80-1.91 (m, 1H) 2.85 (d,  $J=11.49$  Hz, 1H) 3.15-3.27 (m, 2H) 3.35-3.46 (m, 1H) 4.16-4.26 (m, 1H) 4.87 (d,  $J=3.42$  Hz, 1H) 7.35 (d,  $J=8.56$  Hz, 2H) 7.85 (d,  $J=9.05$  Hz,

## 116

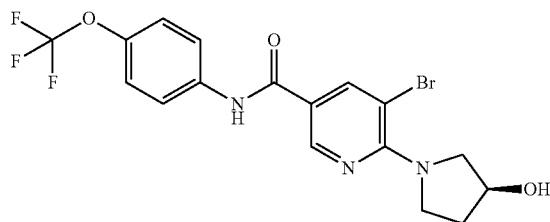
## Example 33

(S)-6-(3-Hydroxypyrrolidin-1-yl)-5-(pyrimidin-5-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide



(S)-5-Bromo-6-(3-hydroxypyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 33.1, 2.4 g, 5.38 mmol) and pyrimidin-5-ylboronic acid (1.33 g, 10.76 mmol) were dissolved in a mixture of DME (15 mL) and EtOH (2.1 mL). A solution of 2 M aq.  $NaHCO_3$  (8.07 mL, 16.14 mmol) was added, the RM was flushed with argon, then  $Pd(PPh_3)_2$   $Cl_2$  (0.453 g, 0.645 mmol) was added and the RM was stirred under argon at 90°C. for 2 h. After cooling to RT, the RM was dissolved in EtOAc and washed with brine. The organic phase was dried over  $Na_2SO_4$  and evaporated to dryness under reduced pressure. The residue was purified by flash chromatography (Silica gel column, 200 g, DCM/MeOH from 2% to 5% MeOH). Treatment with Si-Thiol (1 g) in MeOH and a further purification by flash chromatography (RediSep® Silica gel column, EtOAc/MeOH from 0 to 20% MeOH) afforded the title compound as white crystalline solid. HPLC (Condition 4)  $t_R=4.63$  min, HPLC Chiral (CHIRALPAK® AD-H, 250x4.6 mm, eluent: EtOH, 0.5 mL/min, UV 210 nm)  $t_R=31.72$  min, UPLC-MS (Condition 3)  $t_R=0.91$  min,  $m/z=446.2$   $[M+H]^+$ ;  $^1H$ -NMR (400 MHz, DMSO- $d_6$ )  $\delta$  ppm 1.67-1.78 (m, 1H) 1.79-1.89 (m, 1H) 2.87 (d,  $J=11.73$  Hz, 1H) 3.21 (m,  $J=11.10$ , 4.90 Hz, 2H) 3.37 (m,  $J=7.40$  Hz, 1H) 4.19 (br. s, br. s, 1H) 4.87 (d,  $J=3.52$  Hz, 1H) 7.33 (d,  $J=8.99$  Hz, 2H) 7.75-7.89 (m, 2H) 8.08 (d,  $J=2.35$  Hz, 1H) 8.70-8.83 (m, 1H) 8.87 (s, 2H) 9.18 (s, 1H) 10.16 (s, 1H).

Stage 33.1 (S)-5-Bromo-6-(3-hydroxypyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide



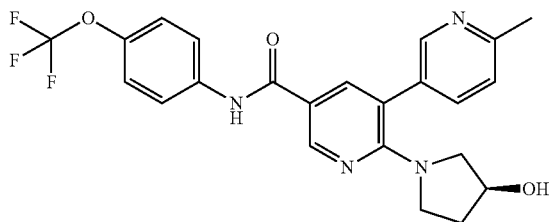
5-Bromo-6-chloro-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 12.2, 2.37 g, 6.0 mmol) and (S)-pyrrolidin-3-ol (0.627 g, 7.2 mmol) were dissolved in iPrOH (6 mL).

## 117

DIPEA (2.1 mL, 12 mmol) was added and the RM mixture was heated at 140° C. for 1 h in a MW vial. After cooling to RT, the RM was dissolved in EtOAc, and washed with 0.5 M HCl and brine. The organic phase was dried over Na<sub>2</sub>SO<sub>4</sub> and concentrated under reduced pressure until the crystallization began. The mixture was triturated with n-pentane, filtered and dried to afford the title compound as a beige crystalline solid. HPLC (Condition 4)  $t_R$ =5.51 min, UPLC-MS (Condition 3)  $t_R$ =1.09 min,  $m/z$ =448.1 [M+H]<sup>+</sup>; <sup>1</sup>H-NMR (400 MHz, DMSO-d<sub>6</sub>)  $\delta$  ppm 1.74-2.03 (m, 2H) 3.55 (d, J=11.34 Hz, 1H) 3.64-3.74 (m, 1H) 3.78-3.89 (m, 2H) 4.33 (br. s, br. s, 1H) 4.97 (d, J=3.13 Hz, 1H) 7.33 (d, J=8.99 Hz, 2H) 7.78-7.90 (m, 2H) 8.32 (d, J=1.56 Hz, 1H) 8.63-8.72 (m, 1H) 10.20 (s, 1H).

## Example 34

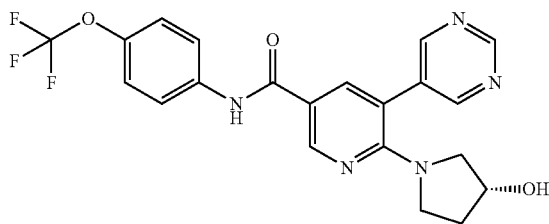
(S)-2-(3-Hydroxypyrrolidin-1-yl)-6'-methyl-N-(4-(trifluoromethoxy)phenyl)-[3,3'-bipyridine]-5-carboxamide



(S)-5-Bromo-6-(3-hydroxypyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 33.1, 60 mg, 0.134 mmol) and (6-methylpyridin-3-yl)boronic acid (36.8 mg, 0.19 mmol) were dissolved in DME (0.5 mL). A solution of 2 M aq. NaHCO<sub>3</sub> (0.2 mL, 0.6 mmol) was added, the RM was flushed with argon, heated to 90° C., and then treated with Pd(PPh<sub>3</sub>)<sub>2</sub>Cl<sub>2</sub> (9.44 mg, 0.013 mmol). The RM was stirred under argon at 90° C. for 2 h in a sealed pressure safe tube. After cooling at RT, the RM was dissolved in EtOAc, and washed with brine. The organic phase was dried over Na<sub>2</sub>SO<sub>4</sub> and evaporated to dryness under reduced pressure. The crude product was purified by flash chromatography (RediSep® Silica gel column, DCM/MeOH from 2% to 10% MeOH) and treated with Si-Thiol (50 mg) in MeOH to afford the title compound as an off-white amorphous solid. HPLC (Condition 4)  $t_R$ =4.09 min, UPLC-MS (Condition 7)  $m/z$ =459.2 [M+H]<sup>+</sup>; <sup>1</sup>H-NMR (400 MHz, DMSO-d<sub>6</sub>)  $\delta$  ppm 1.60-1.75 (m, 1H) 1.76-1.87 (m, 1H) 2.52 (s, 3H) 2.86 (d, J=11.73 Hz, 1H) 3.11-3.24 (m, 2H) 3.27-3.43 (m, 1H) 4.17 (br. s, br. s, 1H) 4.83 (br. s, br. s, 1H) 7.28-7.39 (m, 3H) 7.69 (dd, J=7.82, 1.96 Hz, 1H) 7.79-7.89 (m, 2H) 7.98 (d, J=2.35 Hz, 1H) 8.48 (d, J=2.35 Hz, 1H) 8.73 (d, J=2.35 Hz, 1H) 10.15 (s, 1H).

## Example 35

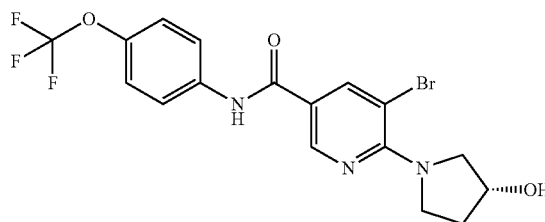
(R)-6-(3-Hydroxypyrrolidin-1-yl)-5-(pyrimidin-5-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide



## 118

5-Bromo-6-chloro-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 35.1, 2 g, 4.48 mmol), pyrimidin-5-ylboronic acid (0.666 g, 5.38 mmol), Pd(PPh<sub>3</sub>)<sub>2</sub>Cl<sub>2</sub> (0.315 g, 0.448 mmol) and Na<sub>2</sub>CO<sub>3</sub> (1.425 g, 13.45 mmol) were added to a MW vial. The vial was sealed, evacuated/purged with argon, and DME (12.55 mL), water (3.59 mL), EtOH (1.793 mL) were added. The RM was stirred at 80° C. for 3.5 h, diluted with THF (4 mL), treated with Si-Thiol (Silicycle, 1.27 mmol/g, 1.765 g, 2.241 mmol), filtered and the filtrate was evaporated off under reduced pressure to give a residue which was purified by flash chromatography (RediSep® Silica gel column, 120 g, cyclohexane/EtOAc-EtOH+0.1% NH<sub>4</sub>OH (9:1), from 60% to 90% EtOAc-EtOH+0.1% NH<sub>4</sub>OH (9:1)). Crystallization from a toluene/EtOH mixture yielded the title compound as a white amorphous solid. HPLC Chiral (CHIRALPAK® AD-H, 250x4.6 mm, eluent: EtOH, 0.5 mL/min, UV 210 nm)  $t_R$ =18.58 min, UPLC-MS (condition 1)  $t_R$ =2.07 min,  $m/z$ =446.1 [M+H]<sup>+</sup>,  $m/z$ =444.2 [M-H]<sup>-</sup>; <sup>1</sup>H-NMR (400 MHz, DMSO-d<sub>6</sub>)  $\delta$  ppm 1.70-1.80 (m, 1H) 1.81-1.92 (m, 1H) 2.89 (d, J=11.25 Hz, 1H) 3.18-3.28 (m, 2H) 3.35-3.44 (m, 1H) 4.22 (br. s, br. s, 1H) 4.89 (d, J=3.42 Hz, 1H) 7.35 (d, J=9.05 Hz, 2H) 7.85 (d, J=9.05 Hz, 2H) 8.10 (d, J=2.45 Hz, 1H) 8.80 (d, J=2.20 Hz, 1H) 8.89 (s, 2H) 9.20 (s, 1H) 10.17 (s, 1H).

Stage 35.1 (R)-5-Bromo-6-(3-hydroxypyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide

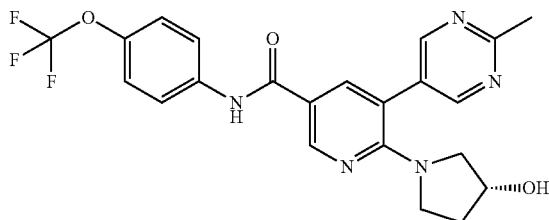


(R)-5-Bromo-6-(3-hydroxypyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 12.2, 2 g, 5.06 mmol) and (R)-pyrrolidin-3-ol (0.529 g, 6.07 mmol) in iPrOH (7.78 mL) were added to a MW vial and subjected to MW irradiation at 140° C. for 30 min. The RM was evaporated to dryness under reduced pressure then extracted from 0.5 M HCl (100 mL) and EtOAc (60 mL). Aq. layer was back extracted with EtOAc (60 mL) and the combined organic layers washed with HCl 0.5 M, water, dried over MgSO<sub>4</sub> and evaporated to dryness under reduced pressure. Trituration of the residue in cyclohexane/EtOAc mixture and filtration of the solid afforded the title compound as a yellow solid. UPLC-MS (condition 1)  $t_R$ =2.64 min,  $m/z$ =445.9/447.9 [M+H]<sup>+</sup>,  $m/z$ =444.0/446.0 [M-H]<sup>-</sup>; <sup>1</sup>H-NMR (400 MHz, DMSO-d<sub>6</sub>)  $\delta$  ppm 1.82-1.91 (m, 1H) 1.91-1.99 (m, 1H) 3.57 (d, J=11.49 Hz, 1H) 3.71 (ddd, J=10.94, 7.89, 3.42 Hz, 1H) 3.81-3.92 (m, 2H) 4.31-4.40 (m, 1H) 4.98 (d, J=3.18 Hz, 1H) 7.35 (d, J=8.31 Hz, 2H) 7.85 (d, J=9.29 Hz, 2H) 8.34 (d, J=2.20 Hz, 1H) 8.68 (d, J=2.20 Hz, 1H) 10.21 (s, 1H).

## 119

## Example 36

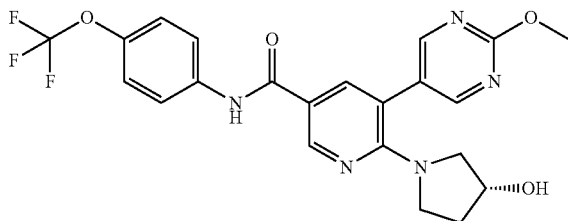
(R)-6-(3-Hydroxypyrrolidin-1-yl)-5-(2-methylpyrimidin-5-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide



(R)-5-Bromo-6-(3-hydroxypyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 35.1, 60 mg, 0.134 mmol), 2-methyl-5-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)pyrimidine (44.4 mg, 0.202 mmol), Pd(PPh<sub>3</sub>)<sub>2</sub>Cl<sub>2</sub> (9.44 mg, 0.013 mmol) and Na<sub>2</sub>CO<sub>3</sub> (42.8 mg, 0.403 mmol) were added to a MW vial and treated with DME (570 μL), EtOH (81 μL) and water (163 μL). The vial was sealed, evacuated/purged with argon, and subjected to MW irradiation at 80° C. with stirring for 2 h, diluted with THF (1 mL), treated with Si-Thiol (Silicycle, 1.27 mmol/g, 52.9 mg, 0.067 mmol), filtered and the filtrate was evaporated off under reduced pressure to give a residue which was purified by preparative HPLC (Condition 12, 20% for 0.2 min then 20% to 50% in 12 min) to yield the title compound as a white solid. UPLC-MS (condition 1) t<sub>R</sub>=1.82 min, m/z=458.2 [M+H]<sup>+</sup>, m/z=443.2 [M-H]<sup>-</sup>; <sup>1</sup>H-NMR (400 MHz, DMSO-d<sub>6</sub>) δ ppm 1.69-1.80 (m, 1H) 1.79-1.92 (m, 1H) 2.69 (s, 3H) 2.91 (d, J=11.00 Hz, 1H) 3.14-3.49 (m, 3H) 4.13-4.28 (m, 1H) 4.83 (br. s, 1H) 7.34 (d, J=8.56 Hz, 2H) 7.80-7.91 (m, 2H) 8.05 (d, J=2.45 Hz, 1H) 8.75 (s, 2H) 8.78 (d, J=2.20 Hz, 1H) 10.14 (s, 1H).

## Example 37

(R)-6-(3-Hydroxypyrrolidin-1-yl)-5-(2-methoxypyrimidin-5-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide



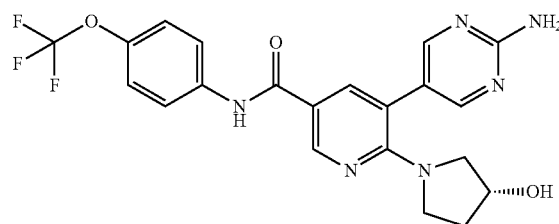
The title compound was prepared in an analogous fashion to that described in Example 36 using (R)-5-bromo-6-(3-hydroxypyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 35.1) and (6-methoxypyridin-3-yl)boronic acid to afford a white solid. UPLC-MS (condition 1) t<sub>R</sub>=2.24 min, m/z=476.2-477.2 [M+H]<sup>+</sup>, m/z=474.2-475.2 [M-H]<sup>-</sup>; <sup>1</sup>H-NMR (400 MHz, DMSO-d<sub>6</sub>) δ ppm 1.71-1.79

## 120

## Example 38

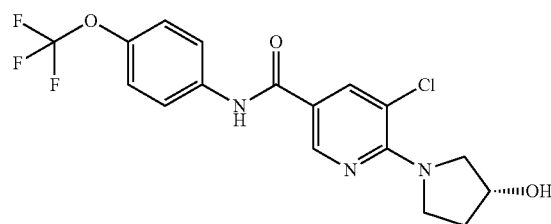
(m, 1H) 1.80-1.91 (m, 1H) 2.96 (d, 1H) 3.21-3.45 (m, 3H) 3.98 (s, 3H) 4.20-4.25 (m, 1H) 4.86-4.90 (m, 1H) 7.35 (d, J=8.80 Hz, 2H) 7.85 (d, 2H) 8.02 (d, J=2.45 Hz, 1H) 8.67 (s, 2H) 8.77 (d, J=2.45 Hz, 1H) 10.15 (s, 1H).

(R)-5-(2-Aminopyrimidin-5-yl)-6-(3-hydroxypyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide



A mixture of (R)-5-chloro-6-(3-hydroxypyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 38.1, 50 mg, 0.124 mmol), (2-aminopyrimidin-5-yl)boronic acid (26 mg, 0.187 mmol), 2 M Na<sub>2</sub>CO<sub>3</sub> (0.124 mL, 0.249 mmol) and DME (2.5 mL) was flushed with argon and PdCl<sub>2</sub>(dppf) (CH<sub>2</sub>Cl<sub>2</sub>) (10 mg, 0.012 mmol) was added. The mixture was subjected to MW irradiation 140° C. for 30 min, passed through a PL-Thiol MP SPE cartridge (StratoSpheres™), the cartridge was washed with MeOH and the solvent was evaporated off under reduced pressure to give a residue which was purified by preparative LC-MS to afford the title compound. LC-MS (Condition 5) t<sub>R</sub>=1.53 min, m/z=461.1 [M+H]<sup>+</sup>, m/z=459.1 [M-H]<sup>-</sup>.

Stage 38.1 (R)-5-Chloro-6-(3-hydroxypyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide



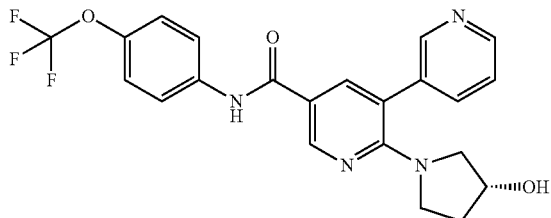
A mixture of 5,6-dichloro-N-(4-(trifluoromethoxy)phenyl)nicotinamide (prepared from 5,6-dichloronicotinic acid in an analogous fashion to that described in Stage 12.2, 1.5 g, 4.27 mmol), (R)-pyrrolidin-3-ol (447 mg, 5.13 mmol), iPrOH (10 mL) and DIPEA (1.104 g, 8.54 mmol) were subjected to MW irradiation at 140° C. for 60 min. The RM was quenched with water (100 mL) and extracted with EtOAc (3x100 mL). The combined organic extracts were washed with brine (100 mL), dried over MgSO<sub>4</sub>, filtered and the filtrate was evaporated off under reduced pressure to afford the title compound as a beige powder. <sup>1</sup>H-NMR (400 MHz, DMSO-d<sub>6</sub>) δ ppm 1.85-1.97 (m, 2H) 3.59 (d, J=12 Hz, 1H) 3.7-3.8 (m, 1H)

## 121

3.8-3.95 (m, 2H) 4.35-4.40 (m, 1H) 5.00 (s, 1H) 7.35 (d, J=2 Hz, 2H) 7.86 (d, J=2 Hz, 2H) 8.17 (s, 1H) 8.66 (s, 1H) 10.22 (s, 1H).

## Example 39

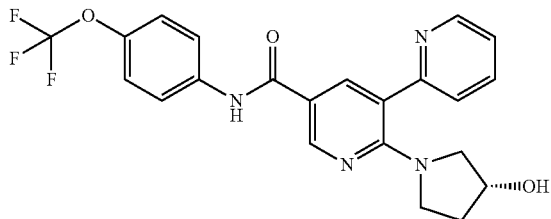
(R)-2-(3-Hydroxypyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)-[3,3'-bipyridine]-5-carboxamide



The title compound was prepared in an analogous fashion to that described in Example 36 using (R)-5-bromo-6-(3-hydroxypyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl) nicotinamide (Stage 35.1) and pyridin-3-ylboronic acid to afford a yellow solid. UPLC-MS (condition 1)  $t_R$ =1.82 min,  $m/z$ =445.1  $[M+H]^+$ ,  $m/z$ =443.2  $[M-H]^-$ ;  $^1H$ -NMR (400 MHz, DMSO- $d_6$ )  $\delta$  ppm 1.67-1.77 (m, 1H) 1.83 (dd, J=8.80, 4.40 Hz, 1H) 2.87 (d, J=11.49 Hz, 1H) 3.14-3.26 (m, 2H) 3.39-3.45 (m, 1H) 4.18 (d, J=2.45 Hz, 1H) 4.83 (br. s, 1H) 7.34 (d, J=8.31 Hz, 2H) 7.50 (dd, J=7.70, 4.77 Hz, 1H) 7.78-7.90 (m, 3H) 8.03 (d, J=2.20 Hz, 1H) 8.55-8.61 (m, 1H) 8.65 (d, J=1.71 Hz, 1H) 8.77 (d, J=2.45 Hz, 1H) 10.17 (s, 1H).

## Example 40

(R)-2'-(3-Hydroxypyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)-[2,3'-bipyridine]-5'-carboxamide

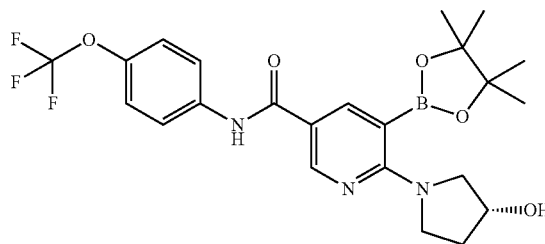


(R)-6-(3-Hydroxypyrrolidin-1-yl)-5-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)-N-(4-(trifluoromethoxy)phenyl) nicotinamide (Stage 40.1, 150 mg, 0.243 mmol), 2-bromopyridine (192 mg, 1.216 mmol), Pd(Ph<sub>3</sub>P)<sub>2</sub>Cl<sub>2</sub> (17.07 mg, 0.024 mmol) and Na<sub>2</sub>CO<sub>3</sub> (77 mg, 0.730 mmol) were added to a MW vial and treated with a mixture of DME (1032  $\mu$ L), water (295  $\mu$ L) and EtOH (147  $\mu$ L). The vial was sealed, evacuated/purged with argon and subjected to MW irradiation at 125° C. for 20 min. The RM was diluted with DME (2 mL), treated with Si-Thiol (Silicycle, 1.43 mmol/g, 102 mg, 0.146 mmol),

## 122

centrifuged, the supernatant was filtered and the solvent was evaporated off under reduced pressure to give a residue which was purified by flash chromatography (RediSep® Silica gel column, 12 g, cyclohexane/EtOAc-EtOH+0.1% NH<sub>4</sub>OH (9:1), from 25% to 100% EtOAc-EtOH+0.1% NH<sub>4</sub>OH (9:1)) and further purification by preparative HPLC (Condition 13, from 5% to 100% in 14 min) yielded the title compound as a yellow solid. UPLC-MS (condition 1)  $t_R$ =1.85 min,  $m/z$ =445.2  $[M+H]^+$ ,  $m/z$ =443.2  $[M-H]^-$ ;  $^1H$ -NMR (400 MHz, DMSO- $d_6$ )  $\delta$  ppm 1.65-1.78 (m, 1H) 1.79-1.94 (m, 1H) 2.85 (d, J=11.49 Hz, 1H) 3.13-3.28 (m, 2H) 3.36-3.50 (m, 1H) 4.19 (d, J=2.20 Hz, 1H) 4.83 (d, J=3.18 Hz, 1H) 7.24-7.44 (m, 3H) 7.53 (d, J=7.82 Hz, 1H) 7.80-7.97 (m, 3H) 8.12 (d, J=2.20 Hz, 1H) 8.66 (dd, J=4.89, 0.73 Hz, 1H) 8.78 (d, J=2.45 Hz, 1H) 10.20 (s, 1H).

Stage 40.1 (R)-6-(3-Hydroxypyrrolidin-1-yl)-5-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide



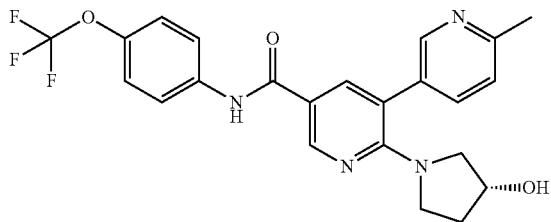
(R)-5-Bromo-6-(3-hydroxypyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 35.1, 376 mg, 0.843 mmol), bis(pinacolato)diboron (856 mg, 3.37 mmol), SPhos (25.9 mg, 0.063 mmol), Pd(OAc)<sub>2</sub> (5.68 mg, 0.025 mmol) and finely ground K<sub>3</sub>PO<sub>4</sub> (537 mg, 2.53 mmol) were added to a MW vial, which was sealed and evacuated/purged with argon. Dioxane (3.371 mL) was added and the RM was stirred at 50° C. for 3 days. A second portion of bis(pinacolato)diboron (428 mg, 1.685 mmol) was then added and the reaction was stirred at 50° C. for 16 h and then at 65° C. overnight. Water (30 mL) was added and the mixture was extracted with EtOAc/TBME (1:1). The combined extracts were washed with brine, dried over Na<sub>2</sub>SO<sub>4</sub> and the solvent was evaporated off under reduced pressure to give a crude product which was purified by flash chromatography (RediSep® Silica gel column, 24 g, cyclohexane/EtOAc-EtOH+0.1% NH<sub>4</sub>OH (9:1), from 20% to 70% EtOAc-EtOH+0.1% NH<sub>4</sub>OH (9:1)) to afford the title compound as a grey solid. UPLC-MS (condition 1)  $t_R$ =2.42 min,  $m/z$ =493.1  $[M+H]^+$ ,  $m/z$ =491.1  $[M-H]^-$ ;  $^1H$ -NMR (400 MHz, DMSO- $d_6$ )  $\delta$  ppm 1.33 (d, J=5.38 Hz, 12H) 1.80-1.93 (m, 1H) 1.99 (s, 1H) 3.27 (s, 1H) 3.40-3.59 (m, 1H) 3.59-3.78 (m, 2H) 4.37 (br. s, 1H) 4.96 (d, J=3.18 Hz,

## 123

1H) 7.34 (d, J=8.56 Hz, 2H) 7.80-7.90 (m, 2H) 8.18 (d, J=2.69 Hz, 1H) 8.76 (d, J=2.69 Hz, 1H) 10.19 (s, 1H).

## Example 41

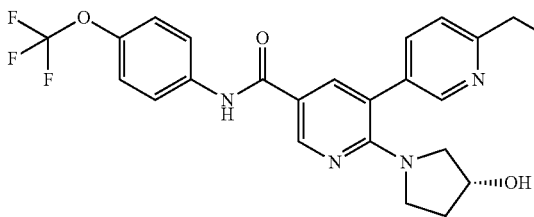
(R)-2-(3-Hydroxypyrrolidin-1-yl)-6'-methyl-N-(4-(trifluoromethoxy)phenyl)-[3,3'-bipyridine]-5-carboxamide



The title compound was prepared in an analogous fashion to that described in Example 36 using (R)-5-bromo-6-(3-hydroxypyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 35.1) and (6-methylpyridin-3-yl)boronic acid to afford a white solid. UPLC-MS (condition 1)  $t_R=1.60$  min,  $m/z=459.0$   $[M+H]^+$ ,  $m/z=457.2$   $[M-H]^-$ ;  $^1H$ -NMR (400 MHz, DMSO- $d_6$ )  $\delta$  ppm 1.73 (dd, J=8.07, 3.91 Hz, 1H) 1.77-1.89 (m, 1H) 2.55 (s, 3H) 2.88 (d, J=11.74 Hz, 1H) 3.17-3.27 (m, 2H) 3.42 (br. s, 1H) 4.19 (br. s, 1H) 4.84 (br. s, 1H) 7.34 (d, J=8.31 Hz, 2H) 7.39 (d, J=7.83 Hz, 1H) 7.75 (dd, J=7.95, 1.83 Hz, 1H) 7.85 (d, 2H) 8.00 (d, J=2.45 Hz, 1H) 8.52 (d, J=1.96 Hz, 1H) 8.75 (d, J=2.20 Hz, 1H) 10.16 (s, 1H).

## Example 42

(R)-6'-(Hydroxymethyl)-2-(3-hydroxypyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)-[3,3'-bipyridine]-5-carboxamide



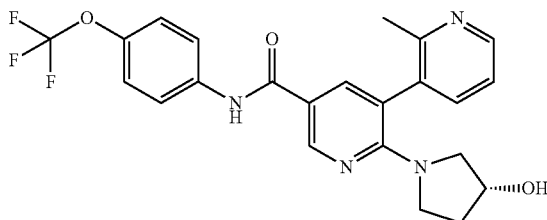
(R)-5-Bromo-6-(3-hydroxypyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 35.1, 89 mg, 0.2 mmol) and (6-(hydroxymethyl)pyridin-3-yl)boronic acid (61.2 mg, 0.4 mmol) were dissolved in DME (0.8 mL). A solution of 2 M  $NaHCO_3$  (0.3 mL, 0.6 mmol) was added, the RM was flushed with argon, heated to 90° C. and treated with  $Pd(PPh_3)_2Cl_2$  (14.0 mg, 0.02 mmol). The RM was stirred under argon at 95° C. for 2 h in a sealed pressure safe tube. After cooling to RT, the RM was dissolved in EtOAc and washed with brine. The organic phase was dried over  $Na_2SO_4$  and evaporated to dryness under reduced pressure. The residue was diluted in MeOH, treated with Si-Thiol (100 mg), the resin was filtered off and the solvent was evaporated off under

## 124

reduced pressure to give a residue which was purified by flash chromatography (Silica gel column, EtOAc/MeOH, from 0 to 20% MeOH) afforded the title compound as an off-white amorphous solid. HPLC (Condition 4)  $t_R=4$  min, UPLC-MS (Condition 3)  $t_R=0.87$  min,  $m/z=475.3$   $[M+H]^+$ ;  $^1H$ -NMR (400 MHz, DMSO- $d_6$ )  $\delta$  ppm 1.63-1.76 (m, 1H) 1.77-1.86 (m, 1H) 2.86 (d, J=11.34 Hz, 1H) 3.11-3.26 (m, 2H) 3.33-3.43 (m, 1H) 4.12-4.22 (m, 1H) 4.61 (d, J=5.87 Hz, 2H) 4.84 (d, J=3.13 Hz, 1H) 5.47 (t, J=5.87 Hz, 1H) 7.33 (d, J=8.99 Hz, 2H) 7.53 (d, J=8.21 Hz, 1H) 7.74-7.88 (m, 3H) 8.00 (d, J=2.35 Hz, 1H) 8.51 (d, J=2.35 Hz, 1H) 8.74 (d, J=2.35 Hz, 1H) 10.15 (s, 1H).

## Example 43

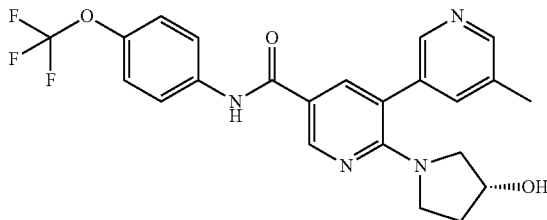
(R)-2-(3-Hydroxypyrrolidin-1-yl)-2'-methyl-N-(4-(trifluoromethoxy)phenyl)-[3,3'-bipyridine]-5-carboxamide



The title compound was prepared in an analogous fashion to that described in Example 36 using (R)-5-bromo-6-(3-hydroxypyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 35.1) and (2-methylpyridin-3-yl)boronic acid to afford a white solid. UPLC-MS (condition 1)  $t_R=1.71$  min,  $m/z=459.0$   $[M+H]^+$ ,  $m/z=547.2$   $[M-H]^-$ .

## Example 44

(R)-2-(3-Hydroxypyrrolidin-1-yl)-5'-methyl-N-(4-(trifluoromethoxy)phenyl)-[3,3'-bipyridine]-5-carboxamide



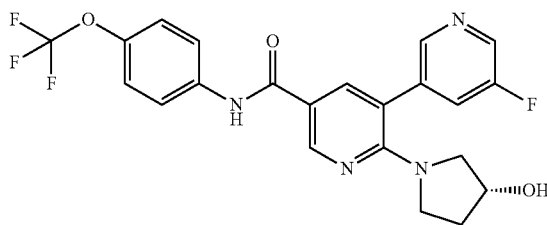
The title compound was prepared in an analogous fashion to that described in Example 36 using (R)-5-bromo-6-(3-hydroxypyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 35.1) and (5-methylpyridin-3-yl)boronic acid to afford a white solid. UPLC-MS (condition 1)  $t_R=1.87$  min,  $m/z=459.1$   $[M+H]^+$ ,  $m/z=457.2$   $[M-H]^-$ ;  $^1H$ -NMR (400 MHz, DMSO- $d_6$ )  $\delta$  ppm 1.66-1.79 (m, 1H) 1.85 (d, J=9.05 Hz, 1H) 2.39 (s, 3H) 2.88 (d, J=11.98 Hz, 1H) 3.15-3.30 (m, 2H) 3.37-3.49 (m, 1H) 4.15-4.25 (m, 1H) 4.83

## 125

(br. s, 0H) 7.35 (d, J=8.31 Hz, 2H) 7.67 (s, 1H) 7.85 (d, 2H) 8.02 (d, J=2.45 Hz, 1H) 8.39-8.49 (m, 2H) 8.77 (d, J=2.45 Hz, 1H) 10.15 (s, 1H).

## Example 45

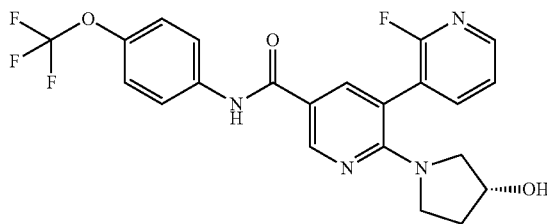
(R)-5'-Fluoro-2-(3-hydroxypyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)-[3,3'-bipyridine]-5-carboxamide



The title compound was prepared in an analogous fashion to that described in Example 36 using (R)-5-bromo-6-(3-hydroxypyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 35.1) and (5-fluoropyridin-3-yl)boronic acid to afford a white solid. UPLC-MS (condition 1)  $t_R$ =2.39 min,  $m/z$ =463.1 [M+H]<sup>+</sup>,  $m/z$ =461.2 [M-H]<sup>-</sup>; <sup>1</sup>H-NMR (400 MHz, DMSO-*d*<sub>6</sub>)  $\delta$  ppm 1.69-1.79 (m, 1H) 1.79-1.91 (m, 1H) 2.88 (d, J=11.00 Hz, 1H) 3.17-3.27 (m, 2H) 3.36-3.45 (m, 1H) 4.21 (br. s, 1H) 4.87 (br. s, 1H) 7.35 (d, J=8.56 Hz, 2H) 7.79-7.90 (m, 3H) 8.08 (d, J=2.20 Hz, 1H) 8.51 (s, 1H) 8.60 (d, J=2.69 Hz, 1H) 8.78 (d, J=2.45 Hz, 1H) 10.17 (s, 1H).

## Example 46

(R)-2'-Fluoro-2-(3-hydroxypyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)-[3,3'-bipyridine]-5-carboxamide



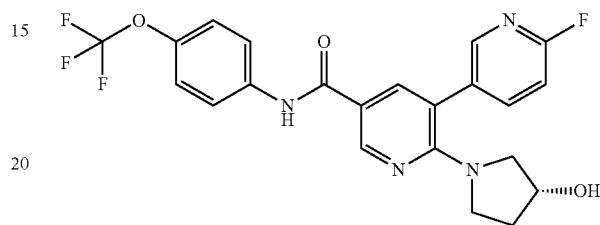
A mixture of (R)-5-chloro-6-(3-hydroxypyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 38.1, 50 mg, 0.124 mmol), (2-fluoropyridin-3-yl)boronic acid (26 mg, 0.187 mmol), 2 M Na<sub>2</sub>CO<sub>3</sub> (0.124 mL, 0.249 mmol) and DME (2.5 mL) was flushed with argon. PdCl<sub>2</sub>(dppf)(CH<sub>2</sub>Cl<sub>2</sub>) (10 mg, 0.012 mmol) was added and the mixture was subjected to MW irradiation 140° C. for 30 min, filtered through a PL-Thiol MP SPE cartridge (StratoSpheres™, 6 mL), the cartridge was washed with MeOH and the solvent was evaporated

## 126

rated off under reduced pressure to give a residue which was purified by preparative LC-MS to afford the title compound. LC-MS (Condition 6)  $t_R$ =1.71 min,  $m/z$ =463.0 [M+H]<sup>+</sup>.

## Example 47

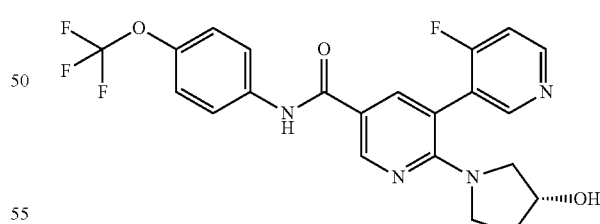
(R)-6'-Fluoro-2-(3-hydroxypyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)-[3,3'-bipyridine]-5-carboxamide



The title compound was prepared in an analogous fashion to that described in Example 54 using (R)-5-bromo-6-(3-hydroxypyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 35.1) and (6-fluoropyridin-3-yl)boronic acid to afford a white solid. LC-MS (Condition 2)  $t_R$ =1.91 min,  $m/z$ =463.2-464.2 [M+H]<sup>+</sup>,  $m/z$ =461 [M-H]<sup>-</sup>; <sup>1</sup>H-NMR (400 MHz, DMSO-*d*<sub>6</sub>)  $\delta$  ppm 1.69-1.78 (m, 1H) 1.79-1.89 (m, 1H) 2.89 (d, J=11.49 Hz, 1H) 3.17-3.28 (m, 2H) 3.34-3.44 (m, 1H) 4.20 (s, 1H) 4.85 (s, 1H) 7.29 (dd, J=8.44, 2.57 Hz, 1H) 7.35 (d, J=8.80 Hz, 2H) 7.85 (d, J=9.29 Hz, 2H) 7.98-8.05 (m, 2H) 8.30 (d, J=1.96 Hz, 1H) 8.77 (d, J=2.20 Hz, 1H) 10.16 (s, 1H).

## Example 48

(R)-4'-Fluoro-2-(3-hydroxypyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)-[3,3'-bipyridine]-5-carboxamide



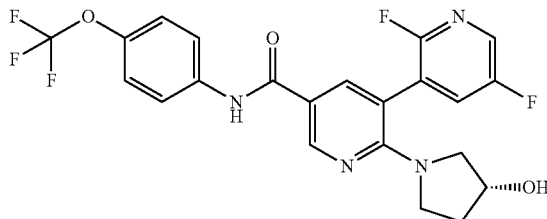
The title compound was prepared in an analogous fashion to that described in Example 7 using (R)-5-bromo-6-(3-hydroxypyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 35.1) and 4-fluoro-3-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)pyridine to afford a solid. UPLC-MS (Condition 3),  $t_R$ =0.97 min,  $m/z$ =463.3 [M+H]<sup>+</sup>; <sup>1</sup>H-NMR (400 MHz, DMSO-*d*<sub>6</sub>)  $\delta$  ppm 1.66-1.76 (m, 1H) 1.77-1.89 (m, 1H) 2.87-2.97 (m, 1H) 3.14-3.21 (m, 1H) 3.30 (s, 2H) 4.14-4.23 (m, 1H) 4.82-4.92 (m, 1H) 7.33 (d, J=8.99 Hz, 2H)

## 127

7.41-7.49 (m, 1H) 7.83 (d, J=8.99 Hz, 2H) 8.03 (d, J=2.35 Hz, 1H) 8.61-8.67 (m, 1H) 8.68-8.77 (m, 1H) 8.79 (d, J=2.35 Hz, 1H) 10.15 (s, 1H).

## Example 49

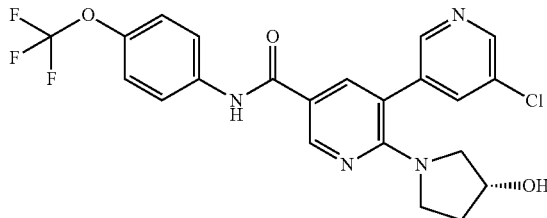
(R)-2',5'-Difluoro-2-(3-hydroxypyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)-[3,3'-bipyridine]-5-carboxamide



The title compound was prepared in an analogous fashion to that described in Example 7 using (R)-5-bromo-6-(3-hydroxypyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 35.1) and 2,5-difluoro-3-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)pyridine to afford a solid. UPLC-MS (Condition 3),  $t_R$ =1.05 min,  $m/z$ =481.3  $[M+H]^+$ ;  $^1H$ -NMR (400 MHz, DMSO- $d_6$ ),  $\delta$  ppm 1.78 (br. s, 1H) 1.87 (br. s, 1H) 2.97 (br. s, 1H) 3.17-3.29 (m, 2H) 3.42 (dd, J=16.03, 7.04 Hz, 1H) 4.23 (br. s, 1H) 4.91 (br. s, 1H) 7.35 (m, J=8.60 Hz, 2H) 7.50 (br. s, 1H) 7.85 (m, J=8.99 Hz, 2H) 8.05-8.13 (m, 1H) 8.28-8.39 (m, 1H) 8.74-8.86 (m, 1H) 10.18 (s, 1H).

## Example 50

(R)-5'-Chloro-2-(3-hydroxypyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)-[3,3'-bipyridine]-5-carboxamide



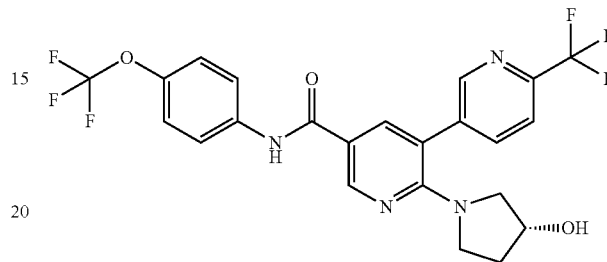
The title compound was prepared in an analogous fashion to that described in Example 54 using (R)-5-bromo-6-(3-hydroxypyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 35.1) and (5-chloropyridin-3-yl)boronic acid to afford a white solid. UPLC-MS (condition 1)  $t_R$ =2.61 min,  $m/z$ =479.1-481.0  $[M+H]^+$ ,  $m/z$ =477.1-479.1  $[M-H]^-$ ;  $^1H$ -NMR (400 MHz, DMSO- $d_6$ ),  $\delta$  ppm 1.70-1.79 (m, 1H) 1.80-1.91 (m, 1H) 2.89 (d, 1H) 3.18-3.28 (m, 2H) 3.35-3.44 (m, 1H) 4.18-4.24 (m, 1H) 4.87 (d, J=3.42 Hz, 1H) 7.35 (d, J=8.80 Hz, 2H) 7.83-7.88 (m, 2H) 8.03 (t, J=1.96 Hz, 1H)

## 128

8.08 (d, J=2.20 Hz, 1H) 8.58 (d, J=1.71 Hz, 1H) 8.64 (d, J=2.45 Hz, 1H) 8.78 (d, J=2.45 Hz, 1H) 10.16 (s, 1H).

## Example 51

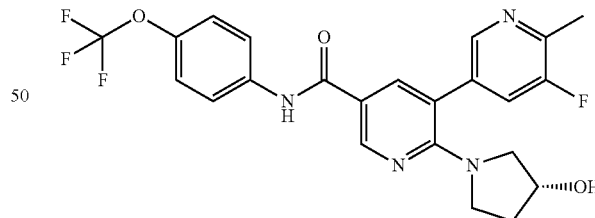
(R)-2-(3-Hydroxypyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)-6'-(trifluoromethyl)-[3,3'-bipyridine]-5-carboxamide



The title compound was prepared in an analogous fashion to that described in Example 54 using (R)-5-bromo-6-(3-hydroxypyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 35.1) and (6-(trifluoromethyl)pyridin-3-yl)boronic acid to afford a white solid. UPLC-MS (condition 1)  $t_R$ =2.80 min,  $m/z$ =513.0  $[M+H]^+$ ,  $m/z$ =511.0  $[M-H]^-$ ;  $^1H$ -NMR (400 MHz, DMSO- $d_6$ ),  $\delta$  ppm 1.69-1.80 (m, 1H) 1.79-1.91 (m, 1H) 2.85 (d, J=11.49 Hz, 1H) 3.16-3.27 (m, 2H) 3.40 (td, J=9.84, 7.21 Hz, 1H) 4.21 (br. s, 1H) 4.87 (br. s, 1H) 7.35 (d, J=8.31 Hz, 2H) 7.81-7.89 (m, 2H) 8.01 (d, J=7.58 Hz, 1H) 8.08-8.13 (m, J=8.31, 2.45, 2.45, 2.45 Hz, 2H) 8.80 (d, J=2.20 Hz, 1H) 8.85 (d, J=1.96 Hz, 1H) 10.18 (s, 1H).

## Example 52

(R)-5'-Fluoro-2-(3-hydroxypyrrolidin-1-yl)-6'-methyl-N-(4-(trifluoromethoxy)phenyl)-[3,3'-bipyridine]-5-carboxamide



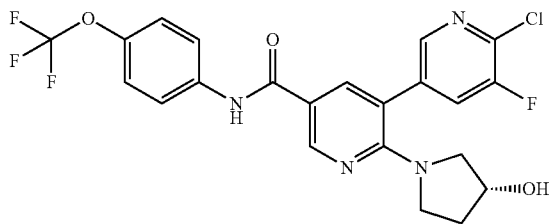
(R)-6'-Chloro-5'-fluoro-2-(3-hydroxypyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)-[3,3'-bipyridine]-5-carboxamide (Example 53, 139 mg, 0.28 mmol) and trimethyl-boroxine (34.4 mg, 0.274 mmol) were dissolved in dioxane (1.5 mL).  $K_2CO_3$  (104 mg, 0.756 mmol) was added, the RM was flushed with argon and  $Pd(PPh_3)_4$  (32.4 mg, 0.028 mmol) was added. The RM was heated overnight at 110° C. After cooling to RT, the RM was dissolved in EtOAc treated with water, and extracted with EtOAc. The combined extracts were dried over  $Na_2SO_4$  and evaporated to dryness under reduced pressure.

## 129

The crude product was purified by flash chromatography (RediSep® Silica gel column, DCM/MeOH from 2% to 5% MeOH). Further purification by reverse phase chromatography (MPLC, Lichroprep 15-25  $\mu$ m column, water+0.1% formic acid/MeCN+0.1% formic acid, gradient 10 to 41% MeCN+0.1% formic acid). The combined pure fractions were neutralized with NaHCO<sub>3</sub> and extracted with EtOAc. The combined organic phases were dried over Na<sub>2</sub>SO<sub>4</sub> and evaporated. The residue was dissolved in MeOH and evaporated under reduced pressure to afford the title compound as an off-white amorphous solid. HPLC (Condition 4)  $t_R$ =5.16 min, UPLC-MS (Condition 7)  $m/z$ =477.2 [M+H]<sup>+</sup>; <sup>1</sup>H-NMR (400 MHz, DMSO-*d*<sub>6</sub>)  $\delta$  ppm 1.65-1.76 (m, 1H) 1.78-1.88 (m, 1H) 2.42-2.56 (m, 3H) 2.87 (d,  $J$ =11.73 Hz, 1H) 3.14-3.28 (m, 2H) 3.33-3.43 (m, 1H) 4.18 (br. s, 1H) 4.84 (d,  $J$ =3.52 Hz, 1H) 7.33 (d,  $J$ =8.99 Hz, 2H) 7.71 (dd,  $J$ =10.17, 1.56 Hz, 1H) 7.79-7.90 (m, 2H) 8.02 (d,  $J$ =2.35 Hz, 1H) 8.34 (s, 1H) 8.75 (d,  $J$ =2.74 Hz, 1H) 10.15 (s, 1H).

## Example 53

(R)-6'-Chloro-5'-fluoro-2-(3-hydroxypyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)-[3,3'-bipyridine]-5-carboxamide



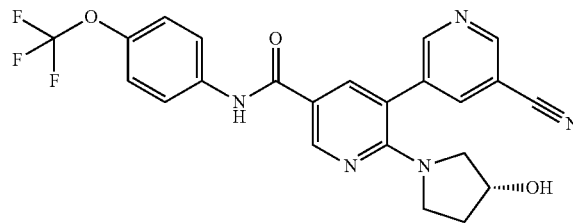
(R)-5-Bromo-6-(3-hydroxypyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 35.1, 300 mg, 0.672 mmol) and 2-chloro-3-fluoro-5-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)pyridine (346 mg, 1.345 mmol) were dissolved in DME (2.7 mL). A solution of 2 M NaHCO<sub>3</sub> (1.01 mL, 2.03 mmol) was added, the RM was flushed with argon and Pd(PPh<sub>3</sub>)<sub>2</sub>Cl<sub>2</sub> (56.6 mg, 0.081 mmol) was added. The RM was stirred under argon at 95° C. for 2 h in a capped pressure safe tube. After cooling to RT, the RM was dissolved in EtOAc, and washed with brine. The organic phase was dried over Na<sub>2</sub>SO<sub>4</sub> and evaporated to dryness under reduced pressure. The crude product was purified by flash chromatography (RediSep® Silica gel column, DCM/MeOH from 2% to 5% MeOH), followed by a second purification (RediSep® Silica gel column, n-hexane/EtOAc, 50 to 100% EtOAc) and treatment with Si-Thiol (200 mg) in MeOH to afford the title compound as a white powder. HPLC (Condition 4)  $t_R$ =5.63 min, UPLC-MS (Condition 7)  $m/z$ =497.1 [M+H]<sup>+</sup>; <sup>1</sup>H-NMR (400 MHz, DMSO-*d*<sub>6</sub>)  $\delta$  ppm 1.65-1.80 (m, 1H) 1.80-1.91 (m, 1H) 2.87 (d,  $J$ =10.56 Hz, 1H) 3.18-3.28 (m, 2H) 3.33-3.50 (m, 1H) 4.20 (br. s, 1H) 4.86 (d,  $J$ =3.52 Hz, 1H) 7.34 (d,

## 130

$J$ =8.99 Hz, 2H) 7.84 (d,  $J$ =8.99 Hz, 2H) 7.99-8.11 (m, 2H) 8.34 (s, 1H) 8.77 (d,  $J$ =2.35 Hz, 1H) 10.16 (s, 1H).

## Example 54

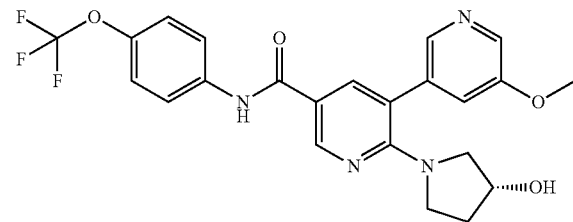
(R)-5'-Cyano-2-(3-hydroxypyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)-[3,3'-bipyridine]-5-carboxamide



(R)-5-Bromo-6-(3-hydroxypyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 35.1, 200 mg, 0.448 mmol), 5-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)nicotinonitrile (206 mg, 0.896 mmol), Pd(PPh<sub>3</sub>)<sub>2</sub>Cl<sub>2</sub> (31.5 mg, 0.045 mmol) and Na<sub>2</sub>CO<sub>3</sub> (143 mg, 1.345 mmol) were added to a MW vial and treated with a mixture of DME (1.902 mL), water (543  $\mu$ L) and EtOH (272  $\mu$ L). The vial was sealed, evacuated/purged with argon and then the RM was subjected to MW irradiation at 120° C. for 10 min, then cooled to RT and finally treated with Si-Thiol (1.27 mmol/g, 176 mg, 0.224 mmol) overnight. The RM was filtered and the solvent was evaporated off under reduced pressure to give a residue which was purified by preparative HPLC (Condition 12, 25% for 0.2 min then 25% to 55% in 14 min.) to yield the title compound as a white solid. UPLC-MS (condition 1)  $t_R$ =2.30 min,  $m/z$ =470.0-471.0 [M+H]<sup>+</sup>,  $m/z$ =468.0-469.0 [M-H]<sup>-</sup>; <sup>1</sup>H-NMR (400 MHz, DMSO-*d*<sub>6</sub>)  $\delta$  ppm 1.70-1.79 (m, 1H) 1.80-1.92 (m, 1H) 2.86 (d,  $J$ =11.25 Hz, 1H) 3.16-3.27 (m, 2H) 3.34-3.44 (m, 1H) 4.17-4.24 (m, 1H) 4.70-5.04 (m, 1H) 7.35 (d,  $J$ =8.80 Hz, 2H) 7.82-7.88 (m, 2H) 8.09 (d,  $J$ =2.45 Hz, 1H) 8.40 (t,  $J$ =2.08 Hz, 1H) 8.79 (d,  $J$ =2.20 Hz, 1H) 8.90 (d,  $J$ =1.96 Hz, 1H) 9.02 (d,  $J$ =1.96 Hz, 1H) 10.17 (s, 1H).

## Example 55

(R)-2-(3-hydroxypyrrolidin-1-yl)-5'-methoxy-N-(4-(trifluoromethoxy)phenyl)-[3,3'-bipyridine]-5-carboxamide



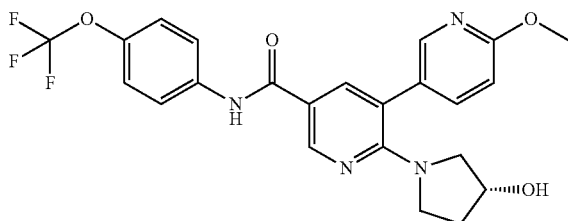
The title compound was prepared in an analogous fashion to that described in Example 54 using (R)-5-bromo-6-(3-hydroxypyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)

## 131

nicotinamide (Stage 35.1) and 3-methoxy-5-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)pyridine to afford a white solid. UPLC-MS (condition 1)  $t_R$ =2.10 min,  $m/z$ =475.2  $[M+H]^+$ ,  $m/z$ =473.2  $[M-H]^-$ ;  $^1H$ -NMR (400 MHz, DMSO- $d_6$ )  $\delta$  ppm 1.67-1.79 (m, 1H) 1.79-1.92 (m, 1H) 2.91 (d,  $J$ =11.25 Hz, 1H) 3.19-3.27 (m, 2H) 3.33-3.47 (m, 1H) 3.89 (s, 3H) 4.16-4.25 (m, 1H) 4.83 (d,  $J$ =3.42 Hz, 1H) 7.34 (d,  $J$ =8.80 Hz, 2H) 7.41 (d,  $J$ =1.96 Hz, 1H) 7.86 (d,  $J$ =9.05 Hz, 2H) 8.04 (d,  $J$ =2.45 Hz, 1H) 8.21 (d,  $J$ =1.47 Hz, 1H) 8.30 (d,  $J$ =2.69 Hz, 1H) 8.76 (d,  $J$ =2.20 Hz, 1H) 10.15 (s, 1H).

## Example 56

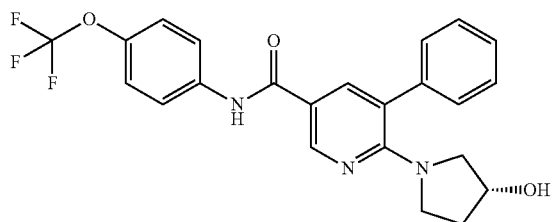
(R)-2-(3-hydroxypyrrolidin-1-yl)-6'-methoxy-N-(4-(trifluoromethoxy)phenyl)-[3,3'-bipyridine]-5-carboxamide



(R)-5-Bromo-6-(3-hydroxypyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 35.1, 60 mg, 0.134 mmol), (6-methoxypyridin-3-yl)boronic acid (25.2 mg, 0.161 mmol),  $Pd_2(dba)_3$  (2.463 mg, 2.69  $\mu$ mol), 2-dicyclohexylphosphino-2',4',6'-triisopropylbiphenyl (2.56 mg, 5.38  $\mu$ mol) and  $K_3PO_4$  (86 mg, 0.403 mmol) were added to a MW vial. The vial was sealed, evacuated/purged with argon, and BuOH (269  $\mu$ L) was added. The RM was stirred at 100° C. for 16 h, diluted with THF (1 mL), treated with Si-Thiol (Silicycle, 1.27 mmol/g, 52.9 mg, 0.067 mmol), filtered and the filtrate was evaporated off under reduced pressure to give a residue which was purified by preparative HPLC (Condition 12, from 30% to 60% in 12 min.) to afford the title compound as a white solid. UPLC-MS (condition 1)  $t_R$ =2.36 min,  $m/z$ =475.2  $[M+H]^+$ ,  $m/z$ =473.2  $[M-H]^-$ ;  $^1H$ -NMR (400 MHz, DMSO- $d_6$ )  $\delta$  ppm 1.68-1.78 (m, 1H) 1.77-1.90 (m, 1H) 2.93 (d,  $J$ =11.74 Hz, 1H) 3.18-3.26 (m, 2H) 3.35-3.46 (m, 1H) 3.91 (s, 3H) 4.20 (br. s, 1H) 4.83 (d,  $J$ =3.42 Hz, 1H) 6.91 (d,  $J$ =8.56 Hz, 1H) 7.34 (d,  $J$ =8.56 Hz, 2H) 7.72 (dd,  $J$ =8.56, 2.45 Hz, 1H) 7.86 (d,  $J$ =9.05 Hz, 2H) 7.97 (d,  $J$ =2.20 Hz, 1H) 8.21 (d,  $J$ =2.45 Hz, 1H) 8.74 (d,  $J$ =2.20 Hz, 1H) 10.14 (s, 1H).

## Example 57

(R)-6-(3-Hydroxypyrrolidin-1-yl)-5-phenyl-N-(4-(trifluoromethoxy)phenyl)nicotinamide

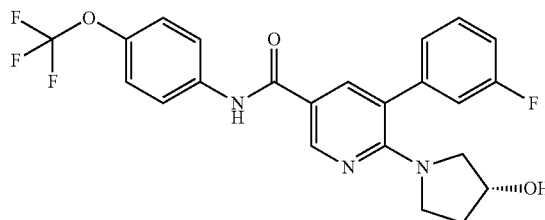


## 132

(R)-5-Bromo-6-(3-hydroxypyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 35.1, 89.0 mg) and phenylboronic acid (48.8 mg) were dissolved in DME (0.8 mL). A solution of 2M  $NaHCO_3$  (0.3 mL, 0.6 mmol) was added, the RM was flushed with argon, heated to 90° C., and treated with  $Pd(PPh_3)_2Cl_2$  (14.0 mg, 0.02 mmol). The RM was stirred under argon at 95° C. for 2 h in a capped pressure safe tube. After cooling at RT, the RM was dissolved in EtOAc and washed with brine. The organic phase was dried over  $Na_2SO_4$  and evaporated to dryness under reduced pressure. The crude product was purified by flash chromatography (RediSep® Silica gel column, DCM/MeOH from 2% to 5% MeOH) and treated with Si-Thiol (80 mg) in MeOH to afford the title compound as an off-white powder. HPLC (Condition 4)  $t_R$ =5.09 min, UPLC-MS (Condition 3)  $t_R$ =1.14 min,  $m/z$ =444.2  $[M+H]^+$ ;  $^1H$ -NMR (400 MHz, DMSO- $d_6$ )  $\delta$  ppm 1.62-1.73 (m, 1H) 1.74-1.85 (m, 1H) 2.85 (d,  $J$ =11.34 Hz, 1H) 3.10-3.26 (m, 2H) 3.32-3.45 (m, 1H) 4.15 (m,  $J$ =2.30 Hz, 1H) 4.80 (d,  $J$ =3.13 Hz, 1H) 7.25-7.51 (m, 7H) 7.78-7.88 (m, 2H) 7.96 (d,  $J$ =2.35 Hz, 1H) 8.72 (d,  $J$ =2.30 Hz, 1H) 10.15 (s, 1H).

## Example 58

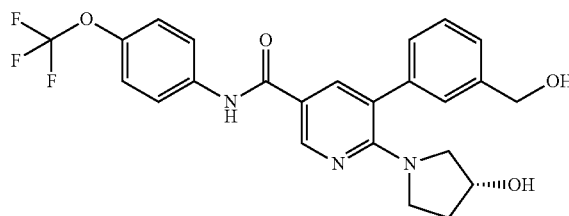
(R)-5-(3-Fluorophenyl)-6-(3-hydroxypyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide



The title compound was prepared in an analogous fashion to that described in Example 57 using (R)-5-bromo-6-(3-hydroxypyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 35.1) and (3-fluorophenyl)boronic acid to afford an off-white solid. HPLC (Condition 4)  $t_R$ =5.48 min, UPLC-MS (Condition 3)  $t_R$ =1.17 min,  $m/z$ =462.2  $[M+H]^+$ ;  $^1H$ -NMR (400 MHz, DMSO- $d_6$ )  $\delta$  ppm 1.72 (m,  $J$ =3.90 Hz, 1H) 1.77-1.89 (m, 1H) 2.86 (d,  $J$ =11.34 Hz, 1H) 3.12-3.27 (m, 2H) 3.40 (m,  $J$ =7.40 Hz, 1H) 4.09-4.22 (m, 1H) 4.82 (d,  $J$ =3.52 Hz, 1H) 7.15-7.28 (m, 3H) 7.34 (d,  $J$ =1.00 Hz, 2H) 7.41-7.53 (m, 1H) 7.77-7.90 (m, 2H) 7.99 (d,  $J$ =2.30 Hz, 1H) 8.73 (d,  $J$ =2.35 Hz, 1H) 10.15 (s, 1H).

## Example 59

(R)-5-(3-(Hydroxymethyl)phenyl)-6-(3-hydroxypyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide

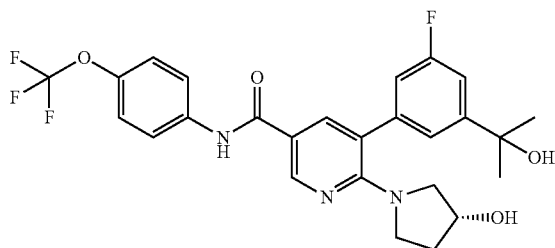


## 133

The title compound was prepared in an analogous fashion to that described in Example 57 using (R)-5-bromo-6-(3-hydroxypyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 35.1) and (3-(hydroxymethyl)phenyl)boronic acid to afford a yellow foam. HPLC (Condition 4)  $t_R=4.57$  min, UPLC-MS (Condition 3)  $t_R=0.99$  min,  $m/z=474.4$   $[M+H]^+$ ;  $^1H$ -NMR (400 MHz, DMSO- $d_6$ )  $\delta$  ppm 1.62-1.73 (m, 1H) 1.80 (m,  $J=8.60$  Hz, 1H) 2.85 (d,  $J=11.73$  Hz, 1H) 3.12-3.26 (m, 2H) 3.34-3.47 (m, 1H) 4.09-4.19 (m, 1H) 4.55 (d,  $J=5.47$  Hz, 2H) 4.80 (d,  $J=3.52$  Hz, 1H) 5.24 (t,  $J=5.67$  Hz, 1H) 7.22 (d,  $J=7.43$  Hz, 1H) 7.27-7.43 (m, 5H) 7.79-7.90 (m, 2H) 7.94 (d,  $J=2.35$  Hz, 1H) 8.71 (d,  $J=2.35$  Hz, 1H) 10.16 (s, 1H).

## Example 60

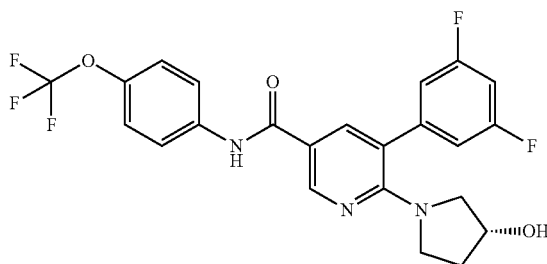
(R)-5-(3-Fluoro-5-(2-hydroxypropan-2-yl)phenyl)-6-(3-hydroxypyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide



The title compound was prepared in an analogous fashion to that described in Example 53 using (R)-5-bromo-6-(3-hydroxypyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 35.1) and 2-(3-fluoro-5-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)phenyl)propan-2-ol and to afford a yellow resin. HPLC (Condition 4)  $t_R=5.18$  min, UPLC-MS (Condition 3)  $t_R=1.10$  min,  $m/z=520.3$   $[M+H]^+$ ;  $^1H$ -NMR (400 MHz, DMSO- $d_6$ )  $\delta$  ppm 1.43 (d,  $J=1.96$  Hz, 6H) 1.65-1.75 (m, 1H) 1.76-1.89 (m, 1H) 2.86 (d,  $J=10.95$  Hz, 1H) 3.13-3.28 (m, 2H) 3.34-3.50 (m, 1H) 4.03-4.22 (m, 1H) 4.82 (d,  $J=2.74$  Hz, 1H) 5.19 (d,  $J=0.78$  Hz, 1H) 7.09 (d,  $J=9.38$  Hz, 1H) 7.18-7.28 (m, 2H) 7.33 (d,  $J=8.99$  Hz, 2H) 7.77-7.88 (m, 2H) 7.98 (m,  $J=2.30, 0.80$  Hz, 1H) 8.67-8.76 (m, 1H) 10.16 (s, 1H).

## Example 61

(R)-5-(3,5-Difluorophenyl)-6-(3-hydroxypyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide

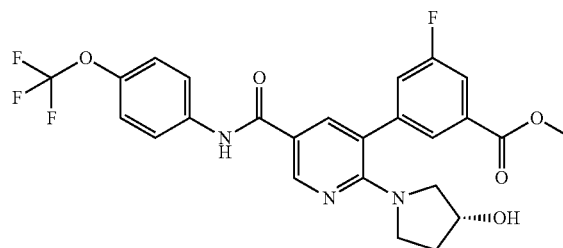


## 134

The title compound was prepared in an analogous fashion to that described in Example 57 using (R)-5-bromo-6-(3-hydroxypyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 35.1) and (3,5-difluorophenyl)boronic acid. HPLC (Condition 4)  $t_R=5.71$  min, UPLC-MS (Condition 3)  $t_R=1.20$  min,  $m/z=480.2$   $[M+H]^+$ ;  $^1H$ -NMR (400 MHz, DMSO- $d_6$ )  $\delta$  ppm 1.67-1.76 (m, 1H) 1.79-1.91 (m, 1H) 2.88 (d,  $J=11.73$  Hz, 1H) 3.16-3.28 (m, 2H) 3.42 (m,  $J=7.00$  Hz, 1H) 4.20 (m,  $J=2.00$  Hz, 1H) 4.85 (d,  $J=3.52$  Hz, 1H) 7.15 (dd,  $J=8.21, 1.95$  Hz, 2H) 7.21-7.29 (m, 1H) 7.33 (d,  $J=8.99$  Hz, 2H) 7.78-7.90 (m, 2H) 8.02 (d,  $J=2.35$  Hz, 1H) 8.74 (d,  $J=2.35$  Hz, 1H) 10.15 (s, 1H).

## Example 62

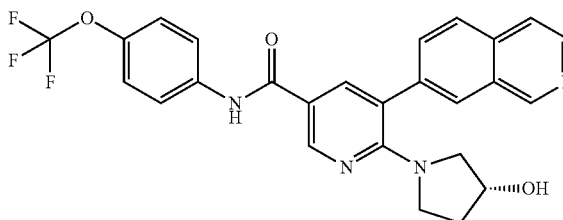
(R)-Methyl 3-fluoro-5-(2-(3-hydroxypyrrolidin-1-yl)-5-((4-(trifluoromethoxy)phenyl)carbamoyl)pyridin-3-yl)benzoate



The title compound was prepared in an analogous fashion to that described in Example 35 using (R)-5-bromo-6-(3-hydroxypyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 35.1) and (3-fluoro-5-(methoxycarbonyl)phenyl)boronic acid to afford a white solid. UPLC-MS (Condition 3),  $t_R=1.18$  min,  $m/z=520.2$   $[M+H]^+$ ;  $^1H$ -NMR (400 MHz, DMSO- $d_6$ )  $\delta$  ppm 1.67-1.75 (m, 1H) 1.77-1.89 (m, 1H) 2.81-2.90 (m, 1H) 3.13-3.27 (m, 2H) 3.33-3.45 (m, 1H) 3.88 (s, 3H) 4.13-4.20 (m, 1H) 4.82 (d,  $J=1.00$  Hz, 1H) 7.33 (d,  $J=8.60$  Hz, 2H) 7.54-7.63 (m, 1H) 7.65-7.73 (m, 1H) 7.74-7.79 (m, 1H) 7.84 (d,  $J=9.38$  Hz, 2H) 8.03 (d,  $J=2.35$  Hz, 1H) 8.75 (d,  $J=2.35$  Hz, 1H) 10.17 (s, 1H).

## Example 63

(R)-6-(3-Hydroxypyrrolidin-1-yl)-5-(isoquinolin-7-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide

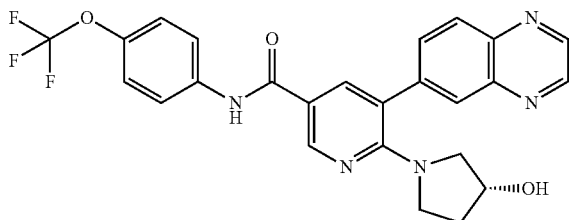


## 135

A mixture of (R)-5-bromo-6-(3-hydroxypyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 35.1, 60 mg, 0.134 mmol), isoquinolin-7-ylboronic acid (35 mg, 0.202 mmol), 2 M Na<sub>2</sub>CO<sub>3</sub> (0.134 mL) and DME (4 mL) was flushed with argon. PdCl<sub>2</sub>(dppf)(CH<sub>2</sub>Cl<sub>2</sub>) (11 mg, 0.013 mmol) was added and the mixture was subjected to MW irradiation at 140° C. for 30 min. The RM was filtered through a PL-Thiol MP SPE cartridge (StratoSpheres™, 6 mL), the cartridge was washed with MeOH and the solvent was evaporated off under reduced pressure to give a residue which was purified by preparative LC-MS to afford the title compound as a beige powder. LC-MS (Condition 6) t<sub>R</sub>=1.33 min, m/z=495.1 [M+H]<sup>+</sup>.

## Example 64

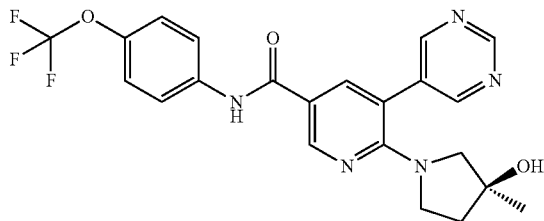
(R)-6-(3-Hydroxypyrrolidin-1-yl)-5-(quinoxalin-6-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide



The title compound was prepared in an analogous fashion to that described in Example 46 using (R)-5-chloro-6-(3-hydroxypyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 38.1) and quinoxalin-6-ylboronic acid. LC-MS (Condition 6) t<sub>R</sub>=1.64 min, m/z=496.0 [M+H]<sup>+</sup>.

## Example 65

(S)-6-(3-Hydroxy-3-methylpyrrolidin-1-yl)-5-(pyrimidin-5-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide

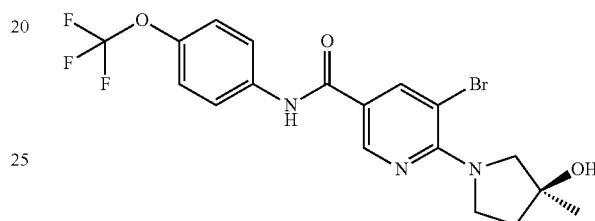


(S)-5-Bromo-6-(3-hydroxy-3-methylpyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 65.1, 60 mg, 0.130 mmol), pyrimidin-5-ylboronic acid (32.3 mg, 0.261 mmol), Pd(PPh<sub>3</sub>)<sub>2</sub>Cl<sub>2</sub> (9.15 mg, 0.013 mmol) and Na<sub>2</sub>CO<sub>3</sub> (41.5 mg, 0.391 mmol) were added to a MW vial and treated with a mixture of DME (553 μL), water (158 μL) and EtOH (79 μL). The vial was sealed, evacuated/purged with argon and was subjected to MW irradiation at 120° C. for 10 min. The RM was diluted with DME (2 mL), treated with Si-Thiol (1.44 mmol/g, 45.3 mg, 0.065 mmol), centrifuged,

## 136

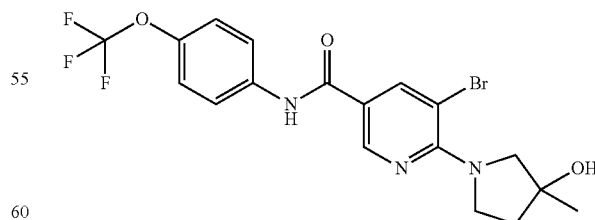
the supernatant was filtered and the solvent was evaporated off under reduced pressure to give a residue which was purified by preparative SFC (Column Silica, from 23% to 28% in 6 min.) to yield the title compound as a white amorphous solid. UPLC-MS (Condition 3) t<sub>R</sub>=0.94 min, m/z=460.4 [M+H]<sup>+</sup>, m/z=458.3 [M-H]<sup>-</sup>; <sup>1</sup>H-NMR (400 MHz, DMSO-d<sub>6</sub>) δ ppm 1.20 (s, 3H) 1.66-1.84 (m, 2H) 2.95 (d, J=11.80 Hz, 1H) 3.02 (d, J=11.17 Hz, 1H) 3.17-3.26 (m, 1H) 3.37-3.47 (m, 1H) 4.75 (s, 1H) 7.35 (d, J=8.53 Hz, 2H) 7.85 (d, J=9.16 Hz, 2H) 8.10 (d, J=2.38 Hz, 1H) 8.78 (d, J=2.13 Hz, 1H) 8.89 (s, 2H) 9.16-9.24 (m, 1H) 10.18 (s, 1H).

Stage 65.1 (S)-5-Bromo-6-(3-hydroxy-3-methylpyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide



The title compound was obtained after chiral separation (preparative HPLC, Chiralcel OD 20 μm 00CM-EK002, 50x5 cm, mobile phase: n-heptane/EtOH (90:10)formic acid, flow rate: 50 mL/min) of racemic 5-bromo-6-(3-hydroxy-3-methylpyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 65.2) (2.18 g, 4.74 mmol) as a white solid. UPLC-MS (Condition 3) t<sub>R</sub>=1.14 min, m/z=460.3/462.3 [M+H]<sup>+</sup>, m/z=458.1/460.1 [M-H]<sup>-</sup>; <sup>1</sup>H-NMR (400 MHz, DMSO-d<sub>6</sub>) δ ppm 1.32 (s, 3H) 1.74-1.91 (m, 2H) 3.60 (d, J=11.32 Hz, 1H) 3.66 (d, J=11.32 Hz, 1H) 3.69-3.74 (m, 1H) 3.86-3.95 (m, 1H) 4.79 (s, 1H) 7.33 (d, J=8.59 Hz, 2H) 7.79-7.87 (m, 2H) 8.31 (d, J=1.95 Hz, 1H) 8.65 (d, J=1.95 Hz, 1H) 10.20 (s, 1H). Chiral HPLC: Column: Chiralcel OD-H 5 μm, 4.6x250 mm, eluent n-heptane/EtOH (9:1), flow at 1.1 mL/min, t<sub>R</sub>=11.29 min, ee=99.0% (UV-210 nm).

Stage 65.2 5-Bromo-6-(3-hydroxy-3-methylpyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide



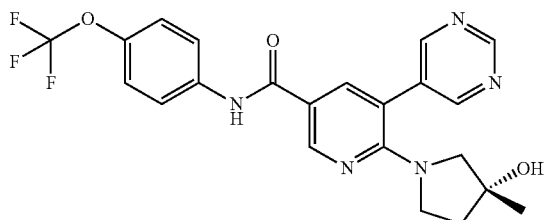
The title compound was prepared in an analogous fashion to that described in Stage 12.1 using 5-bromo-6-chloro-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 12.2) and 3-methylpyrrolidin-3-ol hydrochloride to afford a white solid. UPLC-MS (condition 1) t<sub>R</sub>=2.79 min, m/z=460.9/

## 137

461.9 [M+H]<sup>+</sup>, m/z=458.0/460 [M-H]<sup>-</sup>; <sup>1</sup>H-NMR (400 MHz, DMSO-d<sub>6</sub>) δ ppm 1.34 (s, 3H) 1.76-1.93 (m, 2H) 3.63 (d, 1H) 3.68 (d, 1H) 3.70-3.76 (m, 1H) 3.88-3.97 (m, 1H) 4.82 (s, 1H) 7.35 (d, J=8.31 Hz, 2H) 7.85 (d, J=9.05 Hz, 2H) 8.33 (d, J=2.20 Hz, 1H) 8.67 (d, J=2.20 Hz, 1H) 10.22 (s, 1H).

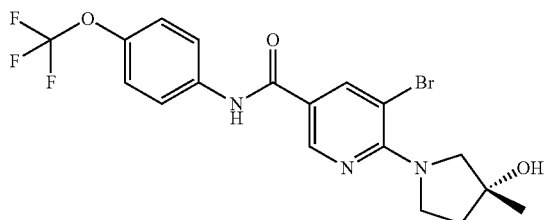
## Example 66

(R)-6-(3-Hydroxy-3-methylpyrrolidin-1-yl)-5-(pyrimidin-5-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide



(R)-5-Bromo-6-(3-hydroxy-3-methylpyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 66.1, 60 mg, 0.130 mmol), pyrimidin-5-ylboronic acid (32.3 mg, 0.261 mmol), Pd(PPh<sub>3</sub>)<sub>2</sub>Cl<sub>2</sub> (9.15 mg, 0.013 mmol) and Na<sub>2</sub>CO<sub>3</sub> (41.5 mg, 0.391 mmol) were added to a MW vial and treated with a mixture of DME (553 μL), water (158 μL) and EtOH (79 μL). The vial was sealed, evacuated/purged with argon and subjected to MW irradiation at 120° C. for 10 min. The RM was diluted with DME (2 mL), treated with Si-Thiol (Silicycle, 1.44 mmol/g, 45.3 mg, 0.065 mmol), centrifuged, the supernatant was filtered and the solvent was evaporated off under reduced pressure to give a residue which was purified by preparative SFC (Column Silica, from 23% to 28% in 6 min) to yield the title compound as a white solid. UPLC-MS (Condition 3) t<sub>R</sub>=0.94 min, m/z=460.4 [M+H]<sup>+</sup>, m/z=458.3 [M-H]<sup>-</sup>; <sup>1</sup>H-NMR (400 MHz, DMSO-d<sub>6</sub>) δ ppm 1.20 (s, 3H) 1.67-1.83 (m, 2H) 2.96 (d, J=10.54 Hz, 1H) 3.03 (d, J=10.54 Hz, 1H) 3.18-3.26 (m, 1H) 3.38-3.47 (m, 1H) 4.75 (s, 1H) 7.36 (d, J=8.28 Hz, 2H) 7.82-7.90 (m, 2H) 8.10 (d, J=2.38 Hz, 1H) 8.79 (d, J=2.38 Hz, 1H) 8.89 (s, 2H) 9.20 (s, 1H) 10.19 (s, 1H).

Stage 66.1 (R)-5-Bromo-6-(3-hydroxy-3-methylpyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide



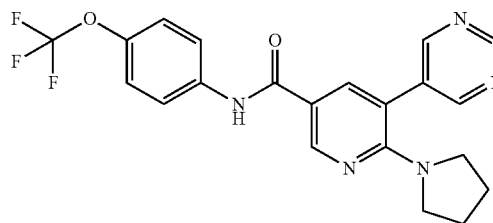
The title compound was obtained after chiral separation (preparative HPLC, Chiralcel OD 20 μm 00CM-EK002, 50×5 cm, mobile phase: n-heptane/EtOH (90:10)formic acid,

## 138

flow rate: 50 mL/min) of racemic 5-bromo-6-(3-hydroxy-3-methylpyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 65.2) (2.18 g, 4.74 mmol) as a white solid. UPLC-MS (Condition 3) t<sub>R</sub>=1.14 min, m/z=460.3/462.3 [M+H]<sup>+</sup>, m/z=458.1/460.1 [M-H]<sup>-</sup>; <sup>1</sup>H-NMR (400 MHz, DMSO-d<sub>6</sub>) δ ppm 1.32 (s, 3H) 1.71-1.95 (m, 2H) 3.60 (d, J=10.93 Hz, 1H) 3.66 (d, J=10.93 Hz, 1H) 3.69-3.74 (m, 1H) 3.85-3.95 (m, 1H) 4.79 (s, 1H) 7.33 (d, J=8.59 Hz, 2H) 7.80-7.86 (m, 2H) 8.31 (d, J=2.34 Hz, 1H) 8.65 (d, J=1.95 Hz, 1H) 10.20 (s, 1H). Chiral HPLC: Column: Chiralcel OD-H 5 μm, 4.6×250 mm, eluent n-heptane/EtOH (9:1), flow at 1.1 mL/min, t<sub>R</sub>=16.66 min, ee=99.4% (UV-210 nm).

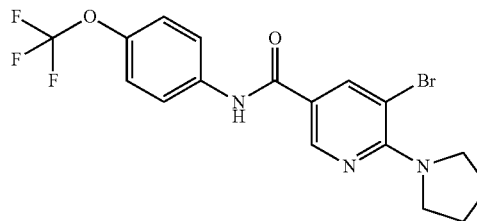
## Example 67

5-(Pyrimidin-5-yl)-6-(pyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide



The title compound was prepared in an analogous fashion to that described in Example 66 using 5-bromo-6-(pyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 67.1) and pyrimidin-5-ylboronic acid to afford a white solid. UPLC-MS (Condition 3) t<sub>R</sub>=1.07 min, m/z=430.4 [M+H]<sup>+</sup>, m/z=428.3 [M-H]<sup>-</sup>; <sup>1</sup>H-NMR (400 MHz, DMSO-d<sub>6</sub>) δ ppm 1.68-1.94 (m, 4H) 3.15 (t, J=6.15 Hz, 4H) 7.37 (d, J=8.78 Hz, 2H) 7.86 (d, J=8.91 Hz, 2H) 8.11 (d, J=2.01 Hz, 1H) 8.80 (d, J=1.88 Hz, 1H) 8.90 (s, 2H) 9.20 (s, 1H) 10.19 (s, 1H).

Stage 67.1 5-Bromo-6-(pyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide



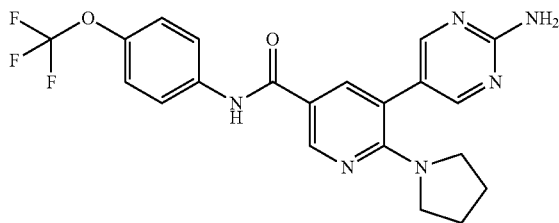
5-Bromo-6-chloro-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 12.2, 1 g, 2.53 mmol) and pyrrolidine (0.544 g, 5.06 mmol) were suspended in iPrOH (2.53 mL), and DIPEA (1.325 mL, 7.58 mmol) was added. The RM was subjected to MW irradiation at 140° C. for 1 hr. The RM was treated with 0.5 M HCl (40 mL) and extracted with EtOAc. The combined extracts were sequentially washed with 0.5 M HCl (40 mL) and brine, dried over Na<sub>2</sub>SO<sub>4</sub> and evaporated to dryness under reduced pressure. Crystallization from a cyclohexane/EtOAc mixture yielded the title compound as an off-

## 139

white solid. UPLC-MS (Condition 3)  $t_R$ =1.34 min,  $m/z$ =430.1/432.1  $[M+H]^+$ ,  $m/z$ =428.3/430.3  $[M-H]^-$ ;  $^1H$ -NMR (400 MHz, DMSO- $d_6$ )  $\delta$  ppm 1.76-2.01 (m, 4H) 3.60-3.80 (m, 4H) 7.33 (d,  $J$ =8.20 Hz, 2H) 7.72-7.91 (m, 2H) 8.32 (d,  $J$ =1.95 Hz, 1H) 8.66 (d,  $J$ =1.95 Hz, 1H) 10.20 (s, 1H).

## Example 68

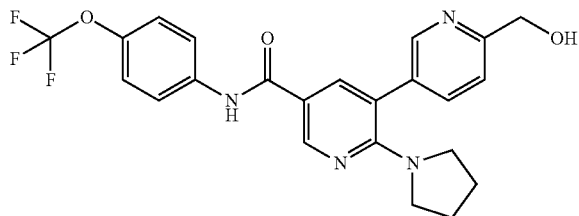
5-(2-Aminopyrimidin-5-yl)-6-(pyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide



The title compound was prepared in an analogous fashion to that described in Example 66 using 5-bromo-6-(pyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 67.1) and (2-aminopyrimidin-5-yl)boronic acid to afford a white solid. UPLC-MS (Condition 3)  $t_R$ =0.99 min,  $m/z$ =445.3  $[M+H]^+$ ,  $m/z$ =443.1  $[M-H]^-$ ;  $^1H$ -NMR (400 MHz, DMSO- $d_6$ )  $\delta$  ppm 1.75-1.84 (m, 4H) 3.18-3.26 (m, 4H) 6.77 (s, 2H) 7.34 (d,  $J$ =8.31 Hz, 2H) 7.86 (d,  $J$ =9.29 Hz, 2H) 7.95 (d,  $J$ =2.45 Hz, 1H) 8.27 (s, 2H) 8.71 (d,  $J$ =2.45 Hz, 1H) 10.12 (s, 1H).

## Example 69

6'-(Hydroxymethyl)-2-(pyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)-[3,3'-bipyridine]-5-carboxamide



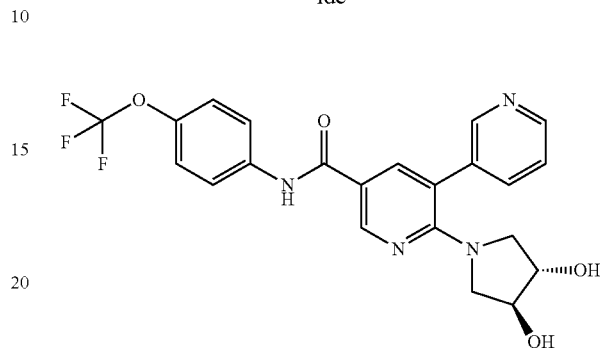
The title compound was prepared in an analogous fashion to that described in Example 66 using 5-bromo-6-(pyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 67.1) and (6-(hydroxymethyl)pyridin-3-yl)boronic acid to afford a white solid. UPLC-MS (Condition 3)  $t_R$ =1.0 min,  $m/z$ =459.2  $[M+H]^+$ ,  $m/z$ =456.9  $[M-H]^-$ ;  $^1H$ -NMR (400 MHz, DMSO- $d_6$ )  $\delta$  ppm 1.67-1.84 (m, 4H) 3.05-3.21 (m, 4H) 4.62 (br. s, 2H) 5.50 (br. s, 1H) 7.34 (d,  $J$ =8.78 Hz, 2H) 7.54

## 140

(d,  $J$ =8.03 Hz, 1H) 7.81 (dd,  $J$ =8.03, 2.26 Hz, 1H) 7.83-7.89 (m, 2H) 8.01 (d,  $J$ =2.38 Hz, 1H) 8.51-8.55 (m, 1H) 8.76 (d,  $J$ =2.38 Hz, 1H) 10.18 (s, 1H).

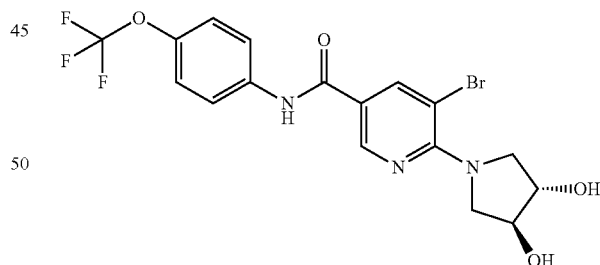
## Example 70

2-((3S,4S)-3,4-Dihydroxypyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)-[3,3'-bipyridine]-5-carboxamide



The title compound was prepared in an analogous fashion to that described in Example 75 using 5-bromo-6-((3S,4S)-3,4-dihydroxypyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 70.1) and pyridin-3-ylboronic acid to afford a white solid. UPLC-MS (condition 1)  $t_R$ =2.01 min,  $m/z$ =461.1  $[M+H]^+$ ,  $m/z$ =459.2  $[M-H]^-$ ;  $^1H$ -NMR (400 MHz, DMSO- $d_6$ )  $\delta$  ppm 2.94 (d,  $J$ =11.74 Hz, 2H) 3.37-3.45 (m, 2H) 3.85 (d,  $J$ =2.69 Hz, 2H) 5.04 (br. s, 2H) 7.35 (d,  $J$ =8.31 Hz, 2H) 7.51 (dd,  $J$ =7.09, 4.89 Hz, 1H) 7.81 (d,  $J$ =7.83 Hz, 1H) 7.86 (d, 2H) 8.04 (d,  $J$ =2.45 Hz, 1H) 8.59 (dd,  $J$ =4.77, 1.59 Hz, 1H) 8.64 (d,  $J$ =1.96 Hz, 1H) 8.76 (d,  $J$ =2.20 Hz, 1H) 10.18 (s, 1H).

Stage 70.1 5-Bromo-6-((3S,4S)-3,4-dihydroxypyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide



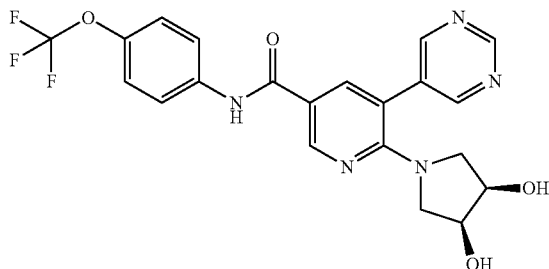
5-Bromo-6-chloro-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 6.2, 500 mg, 1.264 mmol, (3S,4S)-pyrrolidine-3,4-diol (157 mg, 1.517 mmol), DIPEA (442  $\mu$ L, 2.53 mmol) and iPrOH (1.264 mL) were added to a MW vial, which was sealed and subjected to MW irradiation for 30 min at 140° C. The solvent was evaporated off under reduced pressure to give a residue which was treated with 0.5 M HCl (10 mL) and extracted with EtOAc. The combined extracts were washed with HCl 0.5 M and brine, diluted with MeOH (20 mL), dried over  $MgSO_4$  and the solvent was evaporated off under reduced pressure and the product was crystallized

## 141

from EtOAc/MeOH afforded the title compound as a white solid. UPLC-MS (condition 1)  $t_R$ =2.48 min,  $m/z$ =462.0/464.0  $[M+H]^+$ ,  $m/z$ =460.0/462.0  $[M-H]^-$ ;  $^1H$ -NMR (400 MHz, DMSO- $d_6$ )  $\delta$  ppm 3.56 (d,  $J$ =11.25 Hz, 2H) 3.94-4.06 (m, 4H) 4.79 (br. s, 2H) 7.34 (d,  $J$ =8.80 Hz, 2H) 7.88 (d,  $J$ =9.05 Hz, 2H) 8.38 (d,  $J$ =1.96 Hz, 1H) 8.71 (d,  $J$ =1.96 Hz, 1H) 10.34 (s, 1H).

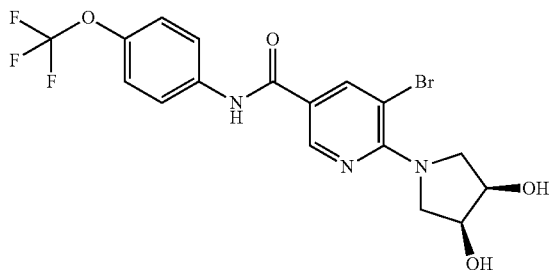
## Example 71

6-((3S,4R)-3,4-Dihydroxypyrrolidin-1-yl)-5-(pyrimidin-5-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide



5-Bromo-6-((3S,4R)-3,4-dihydroxypyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 71.1, 60 mg, 0.13 mmol), pyrimidin-5-ylboronic acid (32.2 mg, 0.26 mmol), Pd(PPh<sub>3</sub>)<sub>2</sub>Cl<sub>2</sub> (9.11 mg, 0.013 mmol) and Na<sub>2</sub>CO<sub>3</sub> (55.0 mg, 0.519 mmol) were added to a MW vial and treated with a mixture of DME (551  $\mu$ L), water (157  $\mu$ L) and EtOH (79  $\mu$ L). The vial was sealed, evacuated/purged with argon and subjected to MW irradiation at 125° C. for 10 min. The RM was diluted with DME (3 mL), treated with Si-Thiol (Silicycle, 1.44 mmol/g, 54.1 mg, 0.078 mmol), centrifuged, the supernatant was filtered and the solvent was evaporated off under reduced pressure to give a residue which was purified by preparative SFC (Column DEAP, isocratic 25% in 9 min.) to yield the title compound as a white amorphous solid. UPLC-MS (Condition 3)  $t_R$ =0.83 min,  $m/z$ =462.1  $[M+H]^+$ ,  $m/z$ =460.1  $[M-H]^-$ ;  $^1H$ -NMR (400 MHz, DMSO- $d_6$ )  $\delta$  ppm 3.05 (dd,  $J$ =10.76, 4.16 Hz, 2H) 3.26 (dd,  $J$ =10.51, 4.89 Hz, 2H) 3.98 (t,  $J$ =3.91 Hz, 2H) 4.89 (br. s, 2H) 7.35 (d,  $J$ =8.56 Hz, 2H) 7.79-7.90 (m, 2H) 8.10 (d,  $J$ =2.20 Hz, 1H) 8.79 (d,  $J$ =2.20 Hz, 1H) 8.88 (s, 2H) 9.20 (s, 1H) 10.17 (s, 1H).

Stage 71.1 5-Bromo-6-((3S,4R)-3,4-dihydroxypyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide

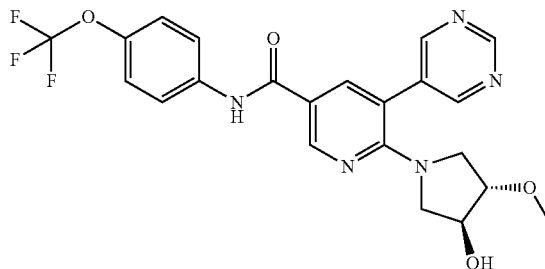


## 142

A mixture of 5-bromo-6-chloro-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 12.2, 1 g, 2.53 mmol) and (3R,4S)-pyrrolidine-3,4-diol (313 mg, 3.03 mmol) in a mixture of DIPEA (0.883 mL, 5.06 mmol) and iPrOH (2.53 mL) was subjected to MW irradiation at 140° C. for 30 min. The RM was treated with 0.5 M aq. HCl (30 mL) and extracted with EtOAc. The combined extracts were washed with sat. NaHCO<sub>3</sub>, brine and dried over Na<sub>2</sub>SO<sub>4</sub>. The crude product was purified by flash chromatography (RediSep® Silica gel column, 40 g, cyclohexane/EtOAc, from 50% to 100% EtOAc) to yield the title compound as a white amorphous solid. UPLC-MS (Condition 3)  $t_R$ =0.98 min,  $m/z$ =462.1-464.0  $[M+H]^+$ ,  $m/z$ =460.1-462.0  $[M-H]^-$ ;  $^1H$ -NMR (400 MHz, DMSO- $d_6$ )  $\delta$  ppm 3.61 (dd,  $J$ =11.13, 4.28 Hz, 2H) 3.84 (dd,  $J$ =10.76, 4.89 Hz, 2H) 4.10 (d,  $J$ =3.42 Hz, 2H) 4.96 (d,  $J$ =3.91 Hz, 2H) 7.35 (d,  $J$ =8.80 Hz, 2H) 7.85 (d,  $J$ =8.80 Hz, 2H) 8.34 (s, 1H) 8.67 (s, 1H) 10.21 (s, 1H).

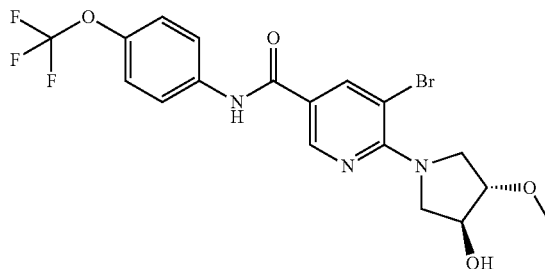
## Example 72

6-(trans-3-Hydroxy-4-methoxypyrrolidin-1-yl)-5-(pyrimidin-5-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide



The title compound was prepared in an analogous fashion to that described in Example 54 using 5-bromo-6-(trans-3-hydroxy-4-methoxypyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 72.1) and pyrimidin-5-ylboronic acid to afford a white solid. UPLC-MS (condition 1)  $t_R$ =2.16 min,  $m/z$ =476.0  $[M+H]^+$ ,  $m/z$ =474.0  $[M-H]^-$ ;  $^1H$ -NMR (400 MHz, DMSO- $d_6$ )  $\delta$  ppm 2.95 (d,  $J$ =11.25 Hz, 1H) 3.14 (d,  $J$ =11.98 Hz, 1H) 3.23 (s, 3H) 3.28-3.35 (m, 1H) 3.46 (dd,  $J$ =11.98, 4.40 Hz, 1H) 3.61-3.65 (m, 1H) 4.08 (br. s, 1H) 5.19 (d,  $J$ =3.67 Hz, 1H) 7.36 (d,  $J$ =8.31 Hz, 2H) 7.85 (d, 2H) 8.12 (d,  $J$ =2.20 Hz, 1H) 8.79 (d,  $J$ =2.45 Hz, 1H) 8.89 (s, 2H) 9.21 (s, 1H) 10.19 (s, 1H).

Stage 72.1 5-Bromo-6-(trans-3-hydroxy-4-methoxypyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide

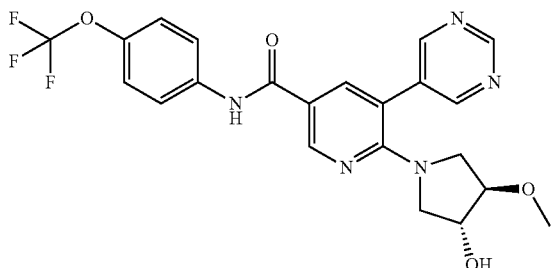


## 143

The title compound was prepared in an analogous fashion to that described in Stage 12.1 using 5-bromo-6-chloro-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 12.2) and Trans-4-methoxy-3-pyrrolidinol hydrochloride to afford a white amorphous solid. UPLC-MS (condition 1)  $t_R$ =2.65 min,  $m/z$ =475.9-477.9 [M+H]<sup>+</sup>,  $m/z$ =474.0-475.9 [M-H]<sup>-</sup>; <sup>1</sup>H-NMR (400 MHz, DMSO-d<sub>6</sub>) δ ppm 3.31 (s, 3H) 3.58 (d, J=11.49 Hz, 1H) 3.66 (d, J=12.23 Hz, 1H) 3.72-3.77 (m, 1H) 3.92 (dd, J=11.86, 4.28 Hz, 1H) 3.97 (dd, J=12.10, 4.28 Hz, 1H) 4.22 (br. s, 1H) 5.30 (d, J=3.18 Hz, 1H) 7.36 (d, J=8.31 Hz, 2H) 7.85 (d, J=9.29 Hz, 2H) 8.36 (d, J=2.20 Hz, 1H) 8.68 (d, J=2.20 Hz, 1H) 10.25 (s, 1H).

## Example 73

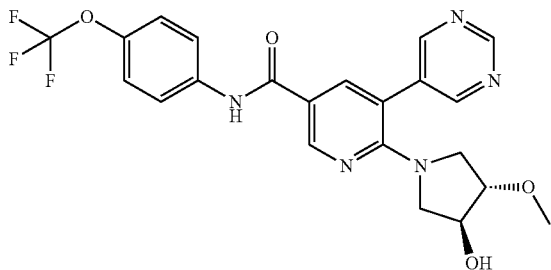
6-((3R,4R)-3-Hydroxy-4-methoxypyrrolidin-1-yl)-5-(pyrimidin-5-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide



The title compound was obtained after chiral separation (preparative HPLC, Chiralcel OD 20 μm 00CM-EK002, 50x5 cm, mobile phase: n-heptane/EtOH (85:15) (v/v), flow rate: 80 mL/min, Detection:UV 254 nm) of racemic 6-((3S,4S)-3-hydroxy-4-methoxypyrrolidin-1-yl)-5-(pyrimidin-5-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Example 72, 128 mg, 0.269 mmol) to as an amorphous white solid. UPLC-MS (Condition 3)  $t_R$ =0.92 min,  $m/z$ =476.3 [M+H]<sup>+</sup>,  $m/z$ =474.4 [M-H]<sup>-</sup>; <sup>1</sup>H-NMR (400 MHz, DMSO-d<sub>6</sub>) δ ppm 2.95 (d, J=11.49 Hz, 1H) 3.14 (d, J=11.98 Hz, 1H) 3.23 (s, 3H) 3.28-3.31 (m, 1H) 3.46 (dd, J=11.98, 4.40 Hz, 1H) 3.60-3.66 (m, 1H) 4.08 (br. s, 1H) 5.19 (d, J=3.67 Hz, 1H) 7.36 (d, J=8.31 Hz, 2H) 7.78-7.91 (m, 2H) 8.12 (d, J=2.45 Hz, 1H) 8.79 (d, J=2.45 Hz, 1H) 8.89 (s, 2H) 9.21 (s, 1H) 10.19 (s, 1H).

## Example 74

6-((3S,4S)-3-Hydroxy-4-methoxypyrrolidin-1-yl)-5-(pyrimidin-5-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide

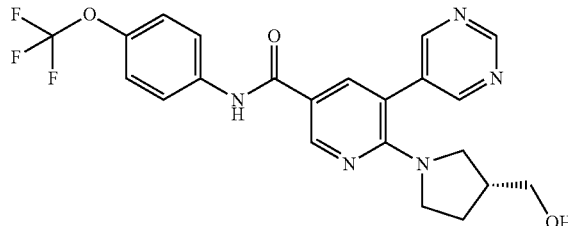


## 144

The title compound was obtained after chiral separation (preparative HPLC, Chiralcel OD 20 μm 00CM-EK002, 50x5 cm, mobile phase: n-heptane/EtOH (85:15)formic acid, flow rate: 80 mL/min, Detection:UV 254 nm) of racemic 6-((3S,4S)-3-hydroxy-4-methoxypyrrolidin-1-yl)-5-(pyrimidin-5-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Example 72, 128 mg, 0.269 mmol) as white needles. UPLC-MS (Condition 3)  $t_R$ =0.92 min,  $m/z$ =476.3 [M+H]<sup>+</sup>,  $m/z$ =474.2 [M-H]<sup>-</sup>; <sup>1</sup>H-NMR (400 MHz, DMSO-d<sub>6</sub>) δ ppm 2.95 (d, J=11.49 Hz, 1H) 3.14 (d, J=11.98 Hz, 1H) 3.23 (s, 3H) 3.30 (m, J=4.60 Hz, 1H) 3.46 (dd, J=12.10, 4.28 Hz, 1H) 3.63 (d, J=1.96 Hz, 1H) 4.08 (br. s, 1H) 5.19 (d, J=3.91 Hz, 1H) 7.36 (d, J=8.56 Hz, 2H) 7.81-7.91 (m, 2H) 8.12 (d, J=2.20 Hz, 1H) 8.79 (d, J=2.20 Hz, 1H) 8.89 (s, 2H) 9.21 (s, 1H) 10.19 (s, 1H).

## Example 75

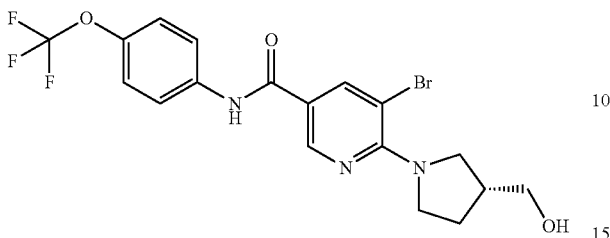
(R)-6-(3-(Hydroxymethyl)pyrrolidin-1-yl)-5-(pyrimidin-5-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide



(R)-5-Bromo-6-(3-(hydroxymethyl)pyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 75.1, 60 mg, 0.13 mmol), pyrimidin-5-ylboronic acid (24.2 mg, 0.196 mmol), Pd(PPh<sub>3</sub>)<sub>2</sub>Cl<sub>2</sub> (9.15 mg, 0.013 mmol) and Na<sub>2</sub>CO<sub>3</sub> (41.5 mg, 0.391 mmol) were added to a MW vial and treated with a mixture of DME (553 μL), water (158 μL) and EtOH (79 μL). The vial was sealed, evacuated/purged with argon and was subjected to MW irradiation at 80° C. for 2 h. The RM was diluted with THF (1 mL), treated with Si-Thiol (Silicycle, 1.27 mmol/g, 51.3 mg, 0.065 mmol), filtered and the filtrate was evaporated off under reduced pressure to give a residue which was purified by preparative HPLC (Condition 12, 25% for 0.2 min then 25% to 55% in 12 min) to yield the title compound as a white solid. UPLC-MS (condition 1)  $t_R$ =2.13 min,  $m/z$ =460.1-461.1 [M+H]<sup>+</sup>,  $m/z$ =458.2 [M-H]<sup>-</sup>; <sup>1</sup>H-NMR (400 MHz, DMSO-d<sub>6</sub>) δ ppm 1.53-1.64 (m, 1H) 1.81-1.90 (m, 1H) 2.19-2.28 (m, 1H) 2.97 (dd, J=10.76, 6.85 Hz, 1H) 3.15-3.39 (m, 5H) 4.61 (t, J=5.01 Hz, 1H) 7.35 (d, J=8.80 Hz, 2H) 7.85 (d, J=9.05 Hz, 2H) 8.09 (d, J=2.20 Hz, 1H) 8.79 (d, J=2.20 Hz, 1H) 8.89 (s, 2H) 9.19 (s, 1H) 10.17 (s, 1H).

## 145

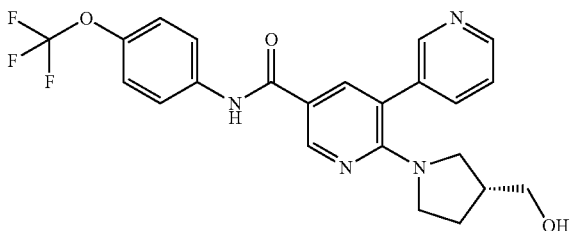
Stage 75.1 (R)-5-Bromo-6-(3-(hydroxymethyl)pyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide



5-Bromo-6-chloro-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 12.2, 500 mg, 1.264 mmol), (R)-beta-prolinol hydrochloride (191 mg, 1.39 mmol) and DIPEA (442  $\mu$ L, 2.53 mmol) in iPrOH (1945  $\mu$ L) were added to a MW vial and subjected to MW irradiation at 140° C. for 30 min. Additional (R)-beta-prolinol hydrochloride (34.8 mg, 0.253 mmol) and DIPEA (221  $\mu$ L, 1.264 mmol) were added to the mixture which was heated at 140° C. for a further 30 min. The vial was cooled to RT and the RM was evaporated to dryness under reduced pressure treated with 0.5 M HCl (20 mL) and extracted with EtOAc. The combined extracts were washed with 0.5 M HCl (10 mL), water, dried over MgSO<sub>4</sub> and evaporated to dryness under reduced pressure. Trituration in a cyclohexane/EtOAc mixture and filtration of the solid afforded the title compound as a white solid. UPLC-MS (condition 1)  $t_R$ =2.76 min,  $m/z$ =460.0-462.0 [M+H]<sup>+</sup>,  $m/z$ =458.0-460.0 [M-H]<sup>-</sup>; <sup>1</sup>H-NMR (400 MHz, DMSO-d<sub>6</sub>)  $\delta$  ppm 1.60-1.77 (m, 1H) 1.91-2.06 (m, 1H) 2.28-2.42 (m, 1H) 3.35-3.51 (m, 2H) 3.56 (dd, J=11.00, 7.34 Hz, 1H) 3.63-3.86 (m, 3H) 4.71 (br. s, 1H) 7.35 (d, J=8.56 Hz, 2H) 7.85 (d, J=9.05 Hz, 2H) 8.34 (d, J=1.96 Hz, 1H) 8.68 (d, J=1.96 Hz, 1H) 10.22 (s, 1H).

## Example 76

(R)-2-(3-(Hydroxymethyl)pyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)-[3,3'-bipyridine]-5-carboxamide



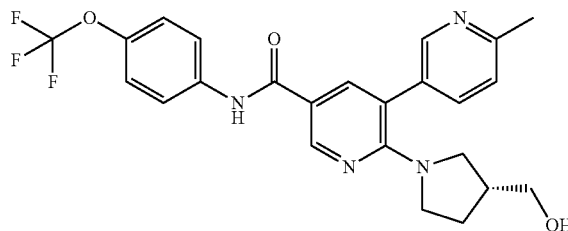
The title compound was prepared in an analogous fashion to that described in Example 75 using (R)-5-bromo-6-(3-(hydroxymethyl)pyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 75.1) and pyridin-3-ylboronic acid to afford a white solid. UPLC-MS (condition 1)  $t_R$ =1.89 min,  $m/z$ =459.1-460.1 [M+H]<sup>+</sup>,  $m/z$ =458.2-457.2 [M-H]<sup>-</sup>; <sup>1</sup>H-NMR (400 MHz, DMSO-d<sub>6</sub>)  $\delta$  ppm 1.50-1.61 (m, 1H)

## 146

1.79-1.88 (m, 1H) 2.17-2.26 (m, 1H) 2.93-3.00 (m, 1H) 3.10-3.37 (m, 5H) 4.60 (t, J=5.14 Hz, 1H) 7.34 (d, J=8.80 Hz, 2H) 7.48 (dd, J=7.82, 4.89 Hz, 1H) 7.79-7.83 (m, 1H) 7.85 (d, J=9.05 Hz, 2H) 8.03 (d, J=2.20 Hz, 1H) 8.57 (dd, J=4.89, 1.47 Hz, 1H) 8.64 (d, J=2.20 Hz, 1H) 8.76 (d, J=2.20 Hz, 1H) 10.17 (s, 1H).

## Example 77

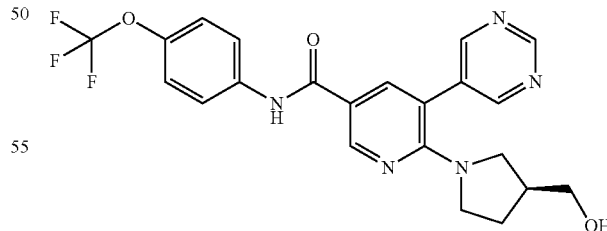
(R)-2-(3-(hydroxymethyl)pyrrolidin-1-yl)-6'-methyl-N-(4-(trifluoromethoxy)phenyl)-[3,3'-bipyridine]-5-carboxamide



The title compound was prepared in an analogous fashion to that described in Example 75 using (R)-5-bromo-6-(3-(hydroxymethyl)pyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 75.1) and (6-methylpyridin-3-yl)boronic acid to afford a white solid. UPLC-MS (condition 1)  $t_R$ =1.81 min,  $m/z$ =473.1-474.1 [M+H]<sup>+</sup>,  $m/z$ =472.2-471.2 [M-H]<sup>-</sup>; <sup>1</sup>H-NMR (400 MHz, DMSO-d<sub>6</sub>)  $\delta$  ppm 1.52-1.61 (m, 1H) 1.78-1.87 (m, 1H) 2.17-2.26 (m, 1H) 2.53 (s, 3H) 2.99 (dd, J=11.00, 6.85 Hz, 1H) 3.11-3.20 (m, 2H) 3.21-3.29 (m, 2H) 3.33-3.37 (m, 1H) 4.60 (t, J=5.14 Hz, 1H) 7.34 (dd, J=8.44, 3.06 Hz, 2H) 7.69 (dd, J=7.82, 2.20 Hz, 1H) 7.85 (d, J=9.05 Hz, 2H) 7.98 (d, J=2.20 Hz, 1H) 8.49 (d, J=1.96 Hz, 1H) 8.74 (d, J=2.20 Hz, 1H) 10.16 (s, 1H).

## Example 78

(S)-6-(3-(hydroxymethyl)pyrrolidin-1-yl)-5-(pyrimidin-5-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide

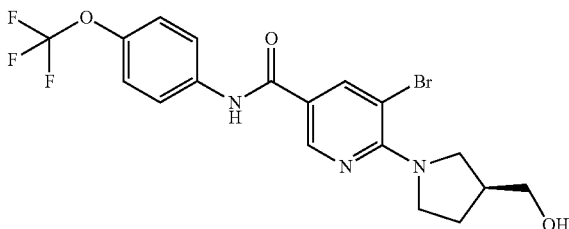


The title compound was prepared in an analogous fashion to that described in Example 75 using (S)-5-bromo-6-(3-(hydroxymethyl)pyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 78.1) and pyrimidin-5-ylboronic acid to afford a white solid. UPLC-MS (condition 1)  $t_R$ =2.12 min,  $m/z$ =460.1-461.1 [M+H]<sup>+</sup>,  $m/z$ =458.2 [M-H]<sup>-</sup>; <sup>1</sup>H-NMR (400 MHz, DMSO-d<sub>6</sub>)  $\delta$  ppm 1.53-1.64 (m, 1H)

## 147

1.81-1.90 (m, 1H) 2.20-2.28 (m, 1H) 2.97 (dd, J=10.76, 6.85 Hz, 1H) 3.15-3.40 (m, 5H) 4.61 (t, J=5.14 Hz, 1H) 7.35 (d, J=8.80 Hz, 2H) 7.85 (d, J=9.05 Hz, 2H) 8.09 (d, J=2.20 Hz, 1H) 8.79 (d, J=2.20 Hz, 1H) 8.89 (s, 2H) 9.19 (s, 1H) 10.16 (s, 1H).

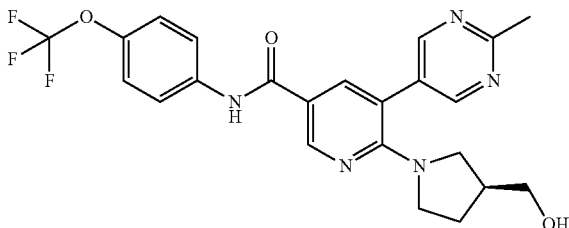
Stage 78.1 (S)-5-bromo-6-(3-(hydroxymethyl)pyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide



5-Bromo-6-chloro-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 12.2, 500 mg, 1.264 mmol), (S)-beta-prolinol hydrochloride (226 mg, 1.643 mmol), DIPEA (662  $\mu$ L, 3.79 mmol) and iPrOH (1.945 mL) were added to a MW vial and subjected to MW irradiation at 140° C. for 60 min. The solvent was evaporated off under reduced pressure and the residue was treated with aq. 0.5 M HCl (20 mL) and extracted with EtOAc. The combined extracts were washed with 0.5 M HCl (10 mL) and water, dried over MgSO<sub>4</sub> and the solvent was evaporated off under reduced pressure to give the product which was triturated with cyclohexane, filtered and dried to afford the title compound as a white solid. UPLC-MS (condition 1)  $t_R$ =2.76 min,  $m/z$ =460.0/462.0 [M+H]<sup>+</sup>,  $m/z$ =458.0/460.0 [M-H]<sup>-</sup>; <sup>1</sup>H-NMR (400 MHz, DMSO-d<sub>6</sub>)  $\delta$  ppm 1.59-1.76 (m, 1H) 1.92-2.04 (m, 1H) 2.26-2.44 (m, 1H) 3.37-3.50 (m, 2H) 3.56 (dd, J=11.00, 7.34 Hz, 1H) 3.67-3.85 (m, 3H) 4.71 (br. s, 1H) 7.35 (d, J=8.56 Hz, 2H) 7.85 (d, 1H) 8.34 (d, J=1.96 Hz, 1H) 8.68 (d, J=1.96 Hz, 1H) 10.21 (s, 1H).

## Example 79

(S)-6-(3-(Hydroxymethyl)pyrrolidin-1-yl)-5-(2-methylpyrimidin-5-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide



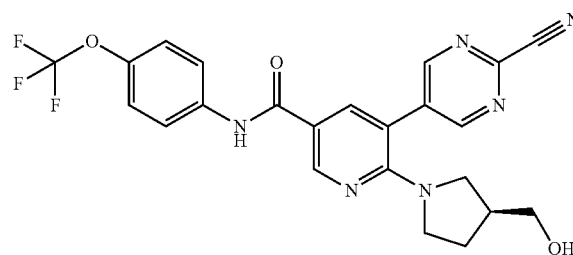
The title compound was prepared in an analogous fashion to that described in Example 75 using (S)-5-bromo-6-(3-(hydroxymethyl)pyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 78.1) and 2-methyl-5-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)pyrimidine to afford an

## 148

off-white solid. UPLC-MS (condition 1)  $t_R$ =2.37 min,  $m/z$ =474.1 [M+H]<sup>+</sup>,  $m/z$ =472.1 [M-H]<sup>-</sup>; <sup>1</sup>H-NMR (400 MHz, DMSO-d<sub>6</sub>)  $\delta$  ppm 1.51-1.65 (m, 1H) 1.79-1.90 (m, 1H) 2.17-2.30 (m, 1H) 2.68 (s, 3H) 2.99 (dd, J=10.76, 6.85 Hz, 1H) 3.11-3.23 (m, 2H) 3.22-3.30 (m, 3H) 4.61 (br. s, 1H) 7.35 (d, J=8.80 Hz, 2H) 7.85 (d, J=9.05 Hz, 2H) 8.04 (d, J=2.45 Hz, 1H) 8.76 (s, 2H) 8.77 (d, J=2.44 Hz, 1H) 10.15 (s, 1H).

## Example 80

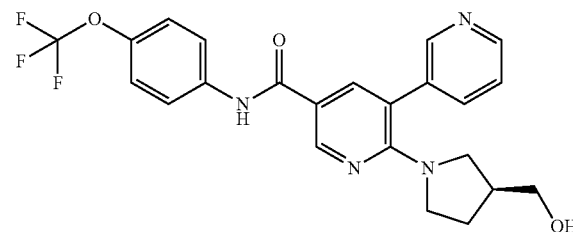
(S)-5-(2-Cyanopyrimidin-5-yl)-6-(3-(hydroxymethyl)pyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide



The title compound was prepared in an analogous fashion to that described in Example 75 using (S)-5-bromo-6-(3-(hydroxymethyl)pyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 78.1) and 5-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)pyrimidine-2-carbonitrile to afford a yellow solid. UPLC-MS (condition 1)  $t_R$ =2.54 min,  $m/z$ =485.0 [M+H]<sup>+</sup>,  $m/z$ =483.1 [M-H]<sup>-</sup>; <sup>1</sup>H-NMR (400 MHz, DMSO-d<sub>6</sub>)  $\delta$  ppm 1.55-1.67 (m, 1H) 1.82-1.93 (m, 1H) 2.21-2.30 (m, 1H) 2.98 (dd, J=11.00, 7.09 Hz, 1H) 3.14-3.30 (m, 4H) 3.33-3.41 (m, 1H) 4.62 (t, J=5.26 Hz, 1H) 7.36 (d, J=8.80 Hz, 2H) 7.85 (d, J=9.05 Hz, 2H) 8.17 (d, J=2.20 Hz, 1H) 8.82 (d, J=2.20 Hz, 1H) 9.10 (s, 2H) 10.20 (s, 1H).

## Example 81

(S)-2-(3-(Hydroxymethyl)pyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)-[3,3'-bipyridine]-5-carboxamide



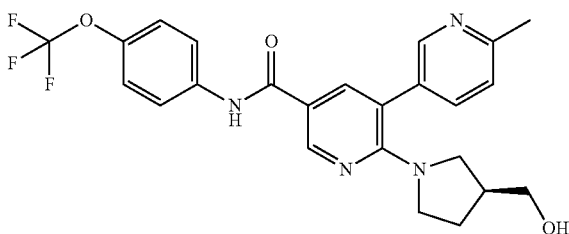
The title compound was prepared in an analogous fashion to that described in Example 75 using (S)-5-bromo-6-(3-(hydroxymethyl)pyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 78.1) and pyridin-3-ylboronic acid to afford a white solid. UPLC-MS (condition 1)  $t_R$ =1.92 min,  $m/z$ =459.1-460.1 [M+H]<sup>+</sup>,  $m/z$ =457.2 [M-H]<sup>-</sup>;

## 149

<sup>1</sup>H-NMR (400 MHz, DMSO-d<sub>6</sub>) δ ppm 1.50-1.61 (m, 1H) 1.78-1.88 (m, 1H) 2.17-2.25 (m, 1H) 2.96 (dd, J=11.00, 6.60 Hz, 1H) 3.10-3.37 (m, 5H) 4.60 (t, J=5.14 Hz, 1H) 7.34 (d, J=8.56 Hz, 2H) 7.48 (dd, 1H) 7.81 (dt, J=7.82, 1.83 Hz, 1H) 7.85 (d, J=9.05 Hz, 2H) 8.03 (d, J=2.20 Hz, 1H) 8.57 (dd, J=4.65, 1.47 Hz, 1H) 8.64 (d, J=1.96 Hz, 1H) 8.76 (d, J=2.45 Hz, 1H) 10.17 (s, 1H).

## Example 82

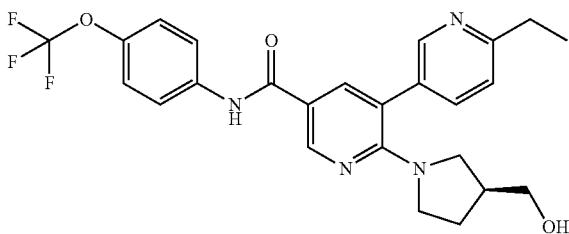
(S)-2-(3-(Hydroxymethyl)pyrrolidin-1-yl)-6'-methyl-N-(4-(trifluoromethoxy)phenyl)-[3,3'-bipyridine]-5-carboxamide



The title compound was prepared in an analogous fashion to that described in Example 75 using (S)-5-bromo-6-(3-(hydroxymethyl)pyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 78.1) and (6-methylpyridin-3-yl)boronic acid to afford a white solid. UPLC-MS (condition 1)  $t_R$ =1.80 min,  $m/z$ =473.1-474.1 [M+H]<sup>+</sup>,  $m/z$ =472.2-471.2 [M-H]<sup>-</sup>; <sup>1</sup>H-NMR (400 MHz, DMSO-d<sub>6</sub>) δ ppm 1.51-1.61 (m, 1H) 1.78-1.88 (m, 1H) 2.17-2.25 (m, 1H) 2.53 (s, 3H) 2.99 (dd, J=11.00, 6.85 Hz, 1H) 3.11-3.19 (m, 2H) 3.22-3.30 (m, 2H) 3.33-3.37 (m, 1H) 4.60 (t, J=4.89 Hz, 1H) 7.34 (dd, J=8.31, 3.42 Hz, 3H) 7.69 (dd, J=7.95, 2.32 Hz, 1H) 7.83-7.88 (m, 2H) 7.98 (d, J=2.45 Hz, 1H) 8.49 (d, J=2.20 Hz, 1H) 8.74 (d, J=2.45 Hz, 1H) 10.16 (s, 1H).

## Example 83

(S)-6'-Ethyl-2-(3-(hydroxymethyl)pyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)-[3,3'-bipyridine]-5-carboxamide



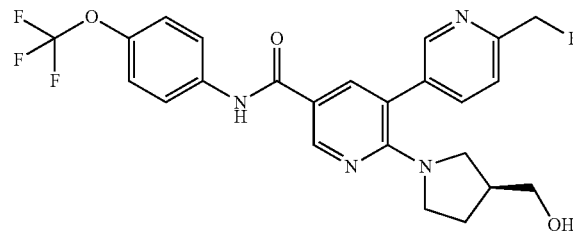
The title compound was prepared in an analogous fashion to that described in Example 75 using (S)-5-bromo-6-(3-(hydroxymethyl)pyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 78.1) and 2-ethyl-5-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)pyridine to afford a yellow solid. UPLC-MS (condition 1)  $t_R$ =1.90 min,

## 150

$m/z$ =487.0 [M+H]<sup>+</sup>,  $m/z$ =485.1 [M-H]<sup>-</sup>; <sup>1</sup>H-NMR (400 MHz, DMSO-d<sub>6</sub>) δ ppm 1.27 (t, J=7.58 Hz, 3H) 1.50-1.62 (m, 1H) 1.77-1.89 (m, 1H) 2.15-2.28 (m, 1H) 2.82 (q, J=7.58 Hz, 2H) 2.99 (dd, J=11.00, 6.60 Hz, 1H) 3.08-3.20 (m, 2H) 3.21-3.30 (m, 2H) 3.29-3.38 (m, 1H) 4.60 (br. s, 1H) 7.34 (d, J=8.80 Hz, 2H) 7.38 (d, J=8.07 Hz, 1H) 7.75 (dd, J=7.82, 1.96 Hz, 1H) 7.86 (d, J=9.05 Hz, 2H) 8.02 (d, J=2.20 Hz, 1H) 8.55 (d, J=1.96 Hz, 1H) 8.75 (d, J=2.20 Hz, 1H) 10.16 (s, 1H).

## Example 84

(S)-6'-(Fluoromethyl)-2-(3-(hydroxymethyl)pyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)-[3,3'-bipyridine]-5-carboxamide

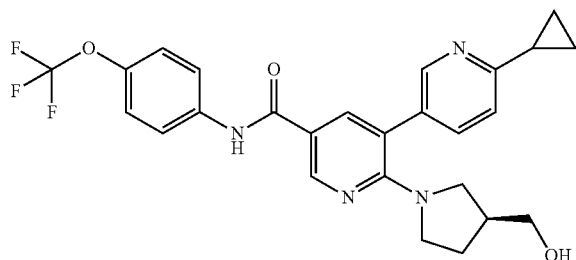


(S)-5-Bromo-6-(3-(hydroxymethyl)pyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 78.1, 92 mg, 0.2 mmol) and 2-(fluoromethyl)-5-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)pyridine (prepared as described in US20090571601) (316 mg 30% ig, 0.4 mmol) were dissolved in DME (0.8 mL). A solution of 2 M NaHCO<sub>3</sub> (0.3 mL, 0.6 mmol) was added, the RM was flushed with argon, heated to 90° C. and Pd(PPh<sub>3</sub>)<sub>2</sub>Cl<sub>2</sub> (14.0 mg, 0.02 mmol) was added. The RM was heated for 2 h at 90° C. After cooling at RT, the RM was dissolved in EtOAc and water, and extracted with EtOAc. The combined extracts were dried over Na<sub>2</sub>SO<sub>4</sub> and evaporated to dryness under reduced pressure. The crude product was first purified by flash chromatography (RediSep® Silica gel column, DCM/MeOH from 2% to 5% MeOH), treated with Si-Thiol (100 mg) in MeOH and further purified by reverse phase chromatography (MPLC, Lichroprep 15-25 μm column, water+0.1% formic acid/MeCN+0.1% formic acid, gradient 10% to 38% MeCN+0.1% formic acid). The combined pure fractions were neutralized with NaHCO<sub>3</sub> and extracted with EtOAc. The combined organic phases were dried over Na<sub>2</sub>SO<sub>4</sub> and evaporated to afford the title compound as an off-white amorphous solid. HPLC (Condition 4)  $t_R$ =4.96 min, UPLC-MS (Condition 3)  $t_R$ =1.07 min,  $m/z$ =491.2 [M+H]<sup>+</sup>; <sup>1</sup>H-NMR (400 MHz, DMSO-d<sub>6</sub>) δ ppm 1.50-1.62 (m, 1H) 1.77-1.89 (m, 1H) 2.15-2.29 (m, 1H) 2.92-3.02 (m, 1H) 3.07-3.38 (m, 4H) 3.42-3.53 (m, 2H) 4.60 (t, J=5.08 Hz, 1H) 5.47 (s, 1H) 7.33 (d, J=8.99 Hz, 2H) 7.58 (d, J=7.82 Hz, 1H) 7.77-7.92 (m, 3H) 8.02 (d, J=2.35 Hz, 1H) 8.64 (d, J=1.56 Hz, 1H) 8.75 (d, J=2.74 Hz, 1H) 10.16 (s, 1H).

## 151

## Example 85

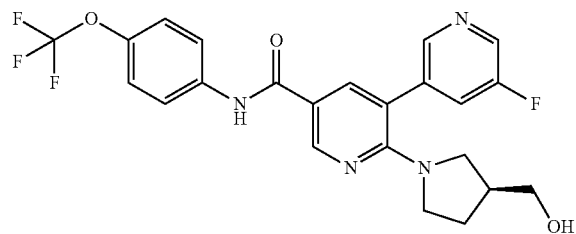
(S)-6'-Cyclopropyl-2-(3-(hydroxymethyl)pyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)-[3,3'-bipyridine]-5-carboxamide



The title compound was prepared in an analogous fashion to that described in Example 75 using (S)-5-bromo-6-(3-(hydroxymethyl)pyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 78.1) and 2-cyclopropyl-5-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)pyridine to afford an off-white solid. UPLC-MS (condition 1)  $t_R$ =2.30 min,  $m/z$ =499.0  $[M+H]^+$ ,  $m/z$ =497.1  $[M-H]^-$ ;  $^1H$ -NMR (400 MHz, DMSO- $d_6$ )  $\delta$  ppm 0.90-1.04 (m, 4H) 1.49-1.62 (m, 1H) 1.77-1.88 (m, 1H) 2.10-2.19 (m, 1H) 2.18-2.26 (m, 1H) 2.99 (dd,  $J$ =11.00, 6.85 Hz, 1H) 3.09-3.20 (m, 2H) 3.21-3.29 (m, 1H) 3.29-3.41 (m, 2H) 4.60 (br. s, 1H) 7.29-7.40 (m, 3H) 7.64 (dd,  $J$ =8.07, 2.20 Hz, 1H) 7.85 (d,  $J$ =9.05 Hz, 2H) 7.99 (d,  $J$ =2.20 Hz, 1H) 8.45 (d,  $J$ =2.20 Hz, 1H) 8.73 (d,  $J$ =2.20 Hz, 1H) 10.14 (s, 1H).

## Example 86

(S)-5'-Fluoro-2-(3-(hydroxymethyl)pyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)-[3,3'-bipyridine]-5-carboxamide



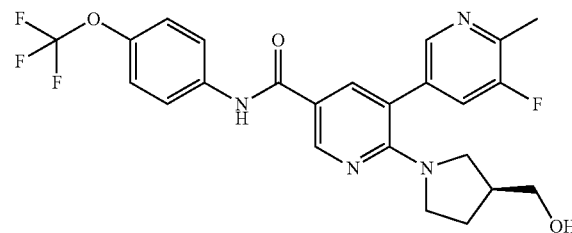
(S)-5-Bromo-6-(3-(hydroxymethyl)pyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 78.1, 60 mg, 0.13 mmol), (5-fluoropyridin-3-yl)boronic acid (60.8 mg, 0.261 mmol),  $Pd(PPh_3)_2Cl_2$  (9.15 mg, 0.013 mmol) and  $Na_2CO_3$  (41.5 mg, 0.391 mmol) were added to a MW vial. The vial was sealed, evacuated/purged with argon, and DME (553  $\mu$ L), water (158  $\mu$ L) and EtOH (79  $\mu$ L) were added. The RM was subjected to MW irradiation at 120° C. for 15 min. The RM was diluted with DME (2 mL), treated with Si-Thiol (Silicycle, 1.27 mmol/g, 103 mg, 0.130 mmol), filtered and the filtrate was evaporated off under reduced pressure to give a residue which was purified by preparative HPLC (Condition

## 152

12, 15% to 45% in 14 min) to yield the title compound as a yellow solid. UPLC-MS (condition 1)  $t_R$ =1.90 min,  $m/z$ =487.0  $[M+H]^+$ ,  $m/z$ =485.1  $[M-H]^-$ ;  $^1H$ -NMR (400 MHz, DMSO- $d_6$ )  $\delta$  ppm 1.27 (t,  $J$ =7.58 Hz, 3H) 1.50-1.62 (m, 1H) 1.77-1.89 (m, 1H) 2.15-2.28 (m, 1H) 2.82 (q,  $J$ =7.58 Hz, 2H) 2.99 (dd,  $J$ =11.00, 6.60 Hz, 1H) 3.08-3.20 (m, 2H) 3.21-3.30 (m, 2H) 3.29-3.38 (m, 1H) 4.60 (br. s, 1H) 7.34 (d,  $J$ =8.80 Hz, 2H) 7.38 (d,  $J$ =8.07 Hz, 1H) 7.75 (dd,  $J$ =7.82, 1.96 Hz, 1H) 7.86 (d,  $J$ =9.05 Hz, 2H) 8.02 (d,  $J$ =2.20 Hz, 1H) 8.55 (d,  $J$ =1.96 Hz, 1H) 8.75 (d,  $J$ =2.20 Hz, 1H) 10.16 (s, 1H).

## Example 87

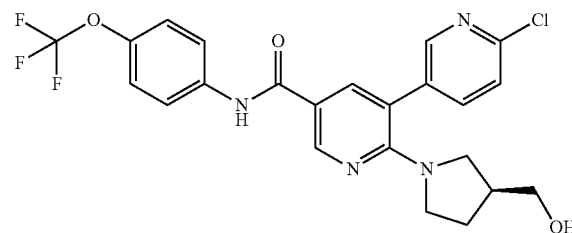
(S)-5'-Fluoro-2-(3-(hydroxymethyl)pyrrolidin-1-yl)-6'-methyl-N-(4-(trifluoromethoxy)phenyl)-[3,3'-bipyridine]-5-carboxamide



The title compound was prepared in an analogous fashion to that described in Example 52 using (S)-6'-chloro-5'-fluoro-2-(3-(hydroxymethyl)pyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)-[3,3'-bipyridine]-5-carboxamide (Example 89) to afford an off-white solid. HPLC (Condition 4)  $t_R$ =5.2 min, UPLC-MS (Condition 7)  $m/z$ =491.2  $[M+H]^+$ ;  $^1H$ -NMR (400 MHz, DMSO- $d_6$ )  $\delta$  ppm 1.56 (m,  $J$ =12.10, 7.40 Hz, 1H) 1.74-1.91 (m, 1H) 2.10-2.28 (m, 1H) 2.48 (s, 3H) 2.98 (dd,  $J$ =11.14, 6.84 Hz, 1H) 3.09-3.19 (m, 2H) 3.21-3.38 (m, 3H) 4.60 (t,  $J$ =5.28 Hz, 1H) 7.33 (d,  $J$ =9.38 Hz, 2H) 7.71 (d,  $J$ =10.17 Hz, 1H) 7.79-7.89 (m, 2H) 8.01 (d,  $J$ =1.00 Hz, 1H) 8.34 (s, 1H) 8.74 (d,  $J$ =2.30 Hz, 1H) 10.14 (s, 1H).

## Example 88

(S)-6'-Chloro-2-(3-(hydroxymethyl)pyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)-[3,3'-bipyridine]-5-carboxamide



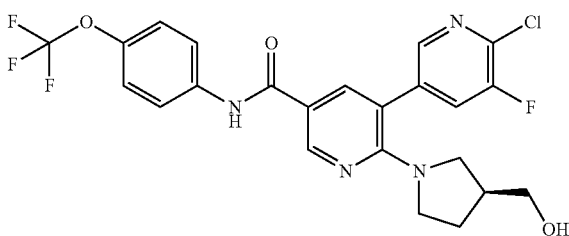
The title compound was prepared in an analogous fashion to that described in Example 86 using (S)-5-bromo-6-(3-(hydroxymethyl)pyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 78.1) and (6-chloropyridin-3-yl)

## 153

boronic acid and to afford an off-white solid. UPLC-MS (condition 1)  $t_R$ =2.51 min,  $m/z$ =493.0-495.0  $[M+H]^+$ ,  $m/z$ =494.1-493.1  $[M-H]^-$ ;  $^1H$ -NMR (400 MHz, DMSO- $d_6$ )  $\delta$  ppm 1.51-1.65 (m, 1H) 1.78-1.92 (m, 1H) 2.23 (ddd,  $J$ =13.63, 7.09, 6.91 Hz, 1H) 2.98 (dd,  $J$ =10.88, 6.97 Hz, 1H) 3.12-3.22 (m, 2H) 3.21-3.31 (m, 3H, in H<sub>2</sub>O) 4.62 (br. s, 1H) 7.35 (d,  $J$ =8.80 Hz, 2H) 7.61 (d,  $J$ =8.31 Hz, 1H) 7.85 (d,  $J$ =9.29 Hz, 2H) 7.89 (dd,  $J$ =8.31, 2.45 Hz, 1H) 8.03 (d,  $J$ =2.44 Hz, 1H) 8.49 (d,  $J$ =2.45 Hz, 1H) 8.77 (d,  $J$ =2.45 Hz, 1H) 10.17 (s, 1H).

## Example 89

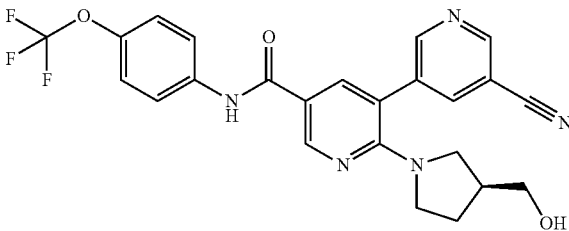
(S)-6'-Chloro-5'-fluoro-2-(3-(hydroxymethyl)pyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)-[3,3'-bipyridine]-5-carboxamide



The title compound was prepared in an analogous fashion to that described in Example 53 using (S)-5-bromo-6-(3-(hydroxymethyl)pyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 78.1) and 2-chloro-3-fluoro-5-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)pyridine to afford an off-white solid. HPLC (Condition 4)  $t_R$ =5.69 min, UPLC-MS (Condition 7)  $m/z$ =511.1  $[M+H]^+$ ;  $^1H$ -NMR (400 MHz, DMSO- $d_6$ )  $\delta$  ppm 1.48-1.65 (m, 1H) 1.84 (m,  $J$ =5.90 Hz, 1H) 2.15-2.28 (m, 1H) 2.98 (dd,  $J$ =10.95, 7.04 Hz, 1H) 3.11-3.41 (m, 5H) 4.61 (t,  $J$ =5.28 Hz, 1H) 7.34 (d,  $J$ =9.38 Hz, 2H) 7.83 (d,  $J$ =9.38 Hz, 2H) 7.99-8.09 (m, 2H) 8.35 (d,  $J$ =1.00 Hz, 1H) 8.76 (d,  $J$ =2.35 Hz, 1H) 10.16 (s, 1H).

## Example 90

(S)-5'-Cyano-2-(3-(hydroxymethyl)pyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)-[3,3'-bipyridine]-5-carboxamide



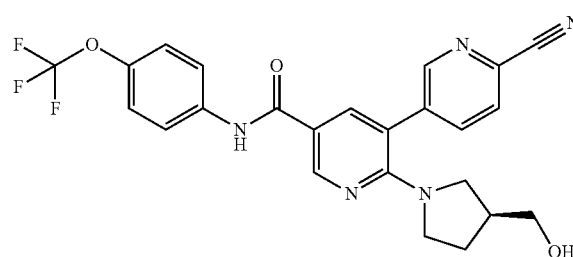
The title compound was prepared in an analogous fashion to that described in Example 75 using (S)-5-bromo-6-(3-(hydroxymethyl)pyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 78.1) and 5-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)pyridine to afford an off-white solid. HPLC (Condition 4)  $t_R$ =5.69 min, UPLC-MS (Condition 7)  $m/z$ =511.1  $[M+H]^+$ ;  $^1H$ -NMR (400 MHz, DMSO- $d_6$ )  $\delta$  ppm 1.48-1.65 (m, 1H) 1.84 (m,  $J$ =5.90 Hz, 1H) 2.15-2.28 (m, 1H) 2.98 (dd,  $J$ =10.95, 7.04 Hz, 1H) 3.11-3.41 (m, 5H) 4.61 (t,  $J$ =5.28 Hz, 1H) 7.34 (d,  $J$ =9.38 Hz, 2H) 7.83 (d,  $J$ =9.38 Hz, 2H) 7.99-8.09 (m, 2H) 8.35 (d,  $J$ =1.00 Hz, 1H) 8.76 (d,  $J$ =2.35 Hz, 1H) 10.16 (s, 1H).

## 154

ethyl-1,3,2-dioxaborolan-2-yl)nicotinonitrile to afford an off-white solid. UPLC-MS (condition 1)  $t_R$ =2.38 min,  $m/z$ =484.0  $[M+H]^+$ ,  $m/z$ =482.0  $[M-H]^-$ ;  $^1H$ -NMR (400 MHz, DMSO- $d_6$ )  $\delta$  ppm 1.47-1.67 (m, 1H) 1.78-1.91 (m, 1H) 2.16-2.30 (m, 1H) 2.96 (dd,  $J$ =11.00, 6.85 Hz, 1H) 3.12-3.19 (m, 2H) 3.19-3.26 (m, 1H) 3.25-3.31 (m, 1H) 3.33-3.39 (m, 1H) 4.62 (t,  $J$ =5.26 Hz, 1H) 7.35 (d,  $J$ =8.56 Hz, 2H) 7.85 (d,  $J$ =9.29 Hz, 2H) 8.08 (d,  $J$ =2.45 Hz, 1H) 8.40 (t,  $J$ =2.08 Hz, 1H) 8.79 (d,  $J$ =2.20 Hz, 1H) 8.91 (d,  $J$ =2.20 Hz, 1H) 9.02 (d,  $J$ =1.96 Hz, 1H) 10.17 (s, 1H).

## Example 91

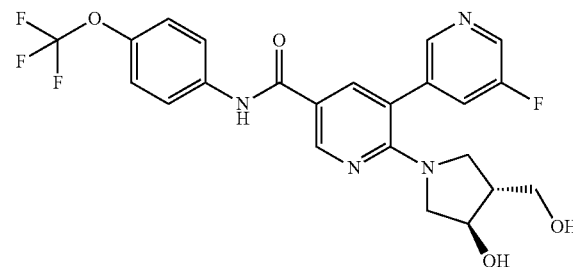
(S)-6'-Cyano-2-(3-(hydroxymethyl)pyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)-[3,3'-bipyridine]-5-carboxamide



The title compound was prepared in an analogous fashion to that described in Example 86 using (S)-5-bromo-6-(3-(hydroxymethyl)pyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 78.1) and (6-cyanopyridin-3-yl)boronic acid to afford a light green solid. UPLC-MS (condition 1)  $t_R$ =2.46 min,  $m/z$ =484.1  $[M+H]^+$ ,  $m/z$ =482.1  $[M-H]^-$ ;  $^1H$ -NMR (400 MHz, DMSO- $d_6$ )  $\delta$  ppm 1.47-1.65 (m, 1H) 1.78-1.93 (m, 1H) 2.17-2.29 (m, 1H) 2.96 (dd,  $J$ =10.64, 6.97 Hz, 1H) 3.11-3.23 (m, 2H) 3.24-3.40 (m, 3H in H<sub>2</sub>O) 4.62 (br. s, 1H) 7.35 (d,  $J$ =8.31 Hz, 2H) 7.85 (d,  $J$ =8.56 Hz, 2H) 8.02-8.17 (m, 3H) 8.79 (d,  $J$ =1.22 Hz, 1H) 8.84 (s, 1H) 10.19 (s, 1H).

## Example 92

5'-Fluoro-2-(trans-3-hydroxy-4-(hydroxymethyl)pyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)-[3,3'-bipyridine]-5-carboxamide

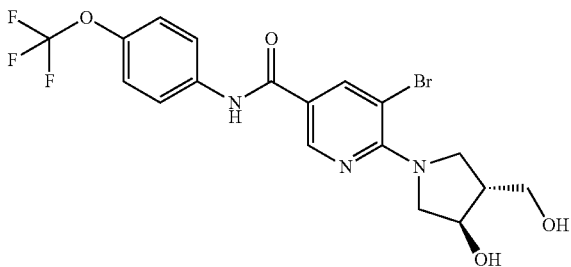


The title compound was prepared in an analogous fashion to that described in Example 86 using bromo-6-(trans-3-hydroxy-4-(hydroxymethyl)pyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 78.1) and 5-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)pyridine to afford an off-white solid. HPLC (Condition 4)  $t_R$ =5.69 min, UPLC-MS (Condition 7)  $m/z$ =511.1  $[M+H]^+$ ;  $^1H$ -NMR (400 MHz, DMSO- $d_6$ )  $\delta$  ppm 1.48-1.65 (m, 1H) 1.84 (m,  $J$ =5.90 Hz, 1H) 2.15-2.28 (m, 1H) 2.98 (dd,  $J$ =10.95, 7.04 Hz, 1H) 3.11-3.41 (m, 5H) 4.61 (t,  $J$ =5.28 Hz, 1H) 7.34 (d,  $J$ =9.38 Hz, 2H) 7.83 (d,  $J$ =9.38 Hz, 2H) 7.99-8.09 (m, 2H) 8.35 (d,  $J$ =1.00 Hz, 1H) 8.76 (d,  $J$ =2.35 Hz, 1H) 10.16 (s, 1H).

## 155

droxy-4-(hydroxymethyl)pyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 92.1) and (5-fluoropyridin-3-yl)boronic acid to afford a white solid. UPLC-MS (Condition 3)  $t_R=0.93$  min,  $m/z=493.2$  [M+H]<sup>+</sup>,  $m/z=491.4$  [M-H]<sup>+</sup>,  $m/z=537.4$  [M+ formic acid-H]<sup>+</sup>; <sup>1</sup>H-NMR (400 MHz, DMSO-d<sub>6</sub>)  $\delta$  ppm 1.99-2.18 (m, 1H) 2.83-2.96 (m, 1H) 3.07-3.18 (m, 1H) 3.18-3.32 (m, 2H) 3.41-3.50 (m, 2H) 3.93-4.03 (m, 1H) 4.62-4.71 (m, 1H) 4.99 (d, J=4.27 Hz, 1H) 7.36 (d, J=9.03 Hz, 2H) 7.82-7.93 (m, 3H) 8.08 (d, J=2.38 Hz, 1H) 8.52 (d, J=1.63 Hz, 1H) 8.61 (d, J=2.63 Hz, 1H) 8.78 (d, J=2.38 Hz, 1H) 10.20 (s, 1H).

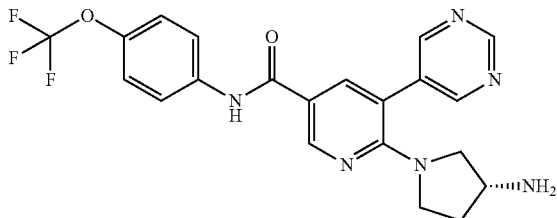
Stage 92.1 5-Bromo-6-(trans-3-hydroxy-4-(hydroxymethyl)pyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide



The title compound was prepared in an analogous fashion to that described in Stage 12.1 using 5-bromo-6-chloro-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Example 35) and 4-(hydroxymethyl)pyrrolidin-3-ol hydrochloride to afford an off-white solid. UPLC-MS (Condition 3)  $t_R=0.98$  min,  $m/z=476.2/478.2$  [M+H]<sup>+</sup>,  $m/z=474.0/476.0$  [M-H]<sup>+</sup>; <sup>1</sup>H-NMR (400 MHz, DMSO-d<sub>6</sub>)  $\delta$  ppm 2.11-2.23 (m, 1H) 3.25-3.34 (m, 2H) 3.39-3.49 (m, 1H) 3.50-3.62 (m, 2H) 3.83-3.96 (m, 2H) 4.04-4.12 (m, 1H) 4.70 (t, J=5.27 Hz, 1H) 5.07 (d, J=4.37 Hz, 1H) 7.33 (d, J=8.75 Hz, 2H) 7.83 (d, J=9.00 Hz, 2H) 8.32 (d, J=2.06 Hz, 1H) 8.66 (d, J=1.80 Hz, 1H) 10.21 (s, 1H).

## Example 93

(R)-6-(3-Aminopyrrolidin-1-yl)-5-(pyrimidin-5-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide

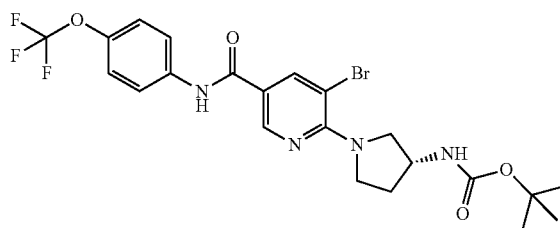


A mixture of (R)-tert-butyl (1-(3-bromo-5-((4-(trifluoromethoxy)phenyl)carbamoyl)pyridin-2-yl)pyrrolidin-3-yl) carbamate (Stage 93.1, 60 mg, 0.110 mmol), pyrimidin-5-ylboronic acid (21 mg, 0.164 mmol), 2M Na<sub>2</sub>CO<sub>3</sub> (0.2 mL, 0.4 mmol) and DME (4 mL) was flushed with argon. PdCl<sub>2</sub>

## 156

(dppf)(CH<sub>2</sub>Cl<sub>2</sub>) (10 mg, 0.012 mmol) was added and the mixture was subjected to MW irradiation 140° C. for 30 min. The RM was filtered through a PL-Thiol MP SPE cartridge (StratoSpheres™, 6 mL), the cartridge was washed with MeOH and the solvent was evaporated off under reduced pressure to give a residue which was purified by preparative LC-MS to afford the title compound. LC-MS (Condition 6)  $t_R=0.88$  min,  $m/z=445.0$  [M+H]<sup>+</sup>.

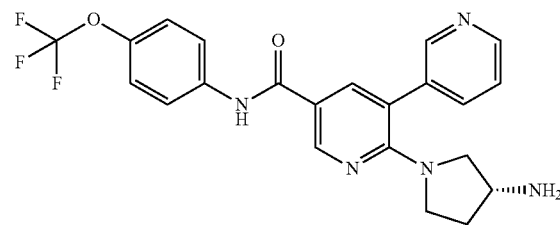
Stage 93.1 (R)-tert-Butyl (1-(3-bromo-5-((4-(trifluoromethoxy)phenyl)carbamoyl)pyridin-2-yl)pyrrolidin-3-yl)carbamate



A mixture of 5-bromo-6-chloro-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 12.2, 0.5 g, 1.264 mmol), (R)-tert-butyl pyrrolidin-3-ylcarbamate (283 mg, 1.517 mmol), iPrOH (4 mL) and DIPEA (0.442 mL, 0.327 g, 2.53 mmol) were subjected to MW irradiation at 140° C. for 30 min. The vial was cooled to RT and the RM was added to water (100 mL) and the resulting precipitate was collected by filtration. The obtained solid was washed with water (50 mL) and dried to afford the title compound as an off-white powder. LC-MS (Condition 6)  $t_R=1.47$  min,  $m/z=488.9/490.9$  [M+H]<sup>+</sup>—H<sub>2</sub>C=C(CH<sub>3</sub>)<sub>2</sub>,  $m/z=545/547.0$  [M+H]<sup>+</sup>.

## Example 94

(R)-2-(3-Aminopyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)-[3,3'-bipyridine]-5-carboxamide

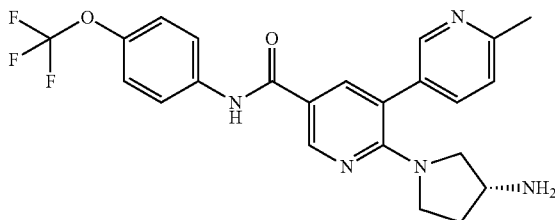


The title compound was prepared in an analogous fashion to that described in Example 93 using (R)-tert-butyl (1-(3-bromo-5-((4-(trifluoromethoxy)phenyl)carbamoyl)pyridin-2-yl)pyrrolidin-3-yl)carbamate (Stage 93.1) and pyridin-3-ylboronic acid. LC-MS (Condition 6)  $t_R=0.79$  min,  $m/z=444.0$  [M+H]<sup>+</sup>.

## 157

## Example 95

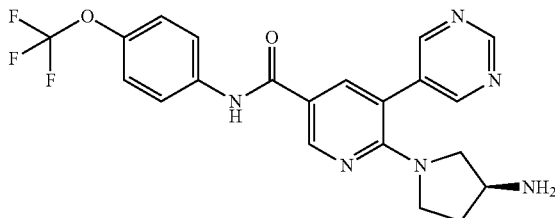
(R)-2-(3-Aminopyrrolidin-1-yl)-6'-methyl-N-(4-(trifluoromethoxy)phenyl)-[3,3'-bipyridine]-5-carboxamide



The title compound was prepared in an analogous fashion to that described in Example 93 using (R)-tert-butyl (1-(3-bromo-5-((4-(trifluoromethoxy)phenyl)carbamoyl)pyridin-2-yl)pyrrolidin-3-yl)carbamate (Stage 93.1) and (6-methylpyridin-3-yl)boronic acid. LC-MS (Condition 6)  $t_R$ =0.79 min,  $m/z$ =458.0  $[M+H]^+$ .

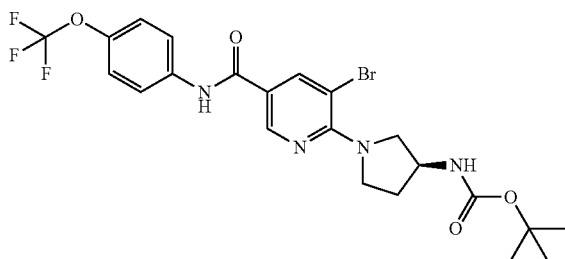
## Example 96

(S)-6-(3-Aminopyrrolidin-1-yl)-5-(pyrimidin-5-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide



The title compound was prepared in an analogous fashion to that described in Example 93 using (S)-tert-butyl (1-(3-bromo-5-((4-(trifluoromethoxy)phenyl)carbamoyl)pyridin-2-yl)pyrrolidin-3-yl)carbamate (Stage 96.1) and pyrimidin-5-ylboronic acid. LC-MS (Condition 6)  $t_R$ =0.89 min,  $m/z$ =445.0  $[M+H]^+$ .

Stage 96.1 (S)-tert-Butyl (1-(3-bromo-5-((4-(trifluoromethoxy)phenyl)carbamoyl)pyridin-2-yl)pyrrolidin-3-yl)carbamate

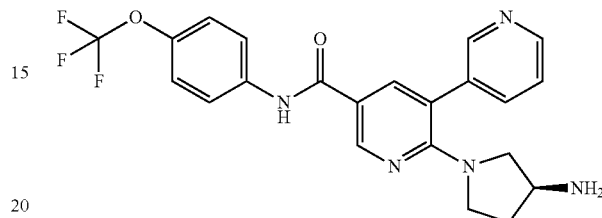


## 158

The title compound was prepared in an analogous fashion to that described in Stage 93.1 using 5-bromo-6-chloro-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 12.2) and (S)-tert-butyl pyrrolidin-3-ylcarbamate. LC-MS (Condition 6)  $t_R$ =1.46 min,  $m/z$ =488.9  $[M+H-H_2C=C(CH_3)_2]$ ,  $m/z$ =544.9  $[M+H]^+$ .

## Example 97

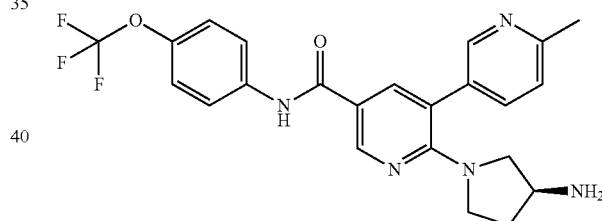
(S)-2-(3-Aminopyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)-[3,3'-bipyridine]-5-carboxamide



The title compound was prepared in an analogous fashion to that described in Example 93 using (S)-tert-butyl (1-(3-bromo-5-((4-(trifluoromethoxy)phenyl)carbamoyl)pyridin-2-yl)pyrrolidin-3-yl)carbamate (Stage 96.1) and pyridin-3-ylboronic acid. LC-MS (Condition 6)  $t_R$ =0.8 min,  $m/z$ =444.0  $[M+H]^+$ .

## Example 98

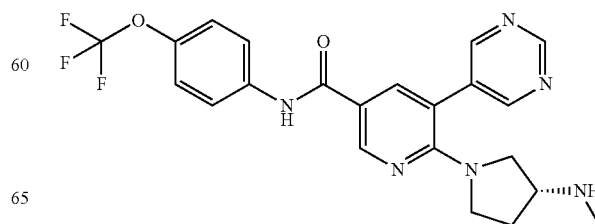
(S)-2-(3-Aminopyrrolidin-1-yl)-6'-methyl-N-(4-(trifluoromethoxy)phenyl)-[3,3'-bipyridine]-5-carboxamide



The title compound was prepared in an analogous fashion to that described in Example 93 using (S)-tert-butyl (1-(3-bromo-5-((4-(trifluoromethoxy)phenyl)carbamoyl)pyridin-2-yl)pyrrolidin-3-yl)carbamate (Stage 96.1) and (6-methylpyridin-3-yl)boronic acid. LC-MS (Condition 6)  $t_R$ =0.79 min,  $m/z$ =448.0  $[M+H]^+$ .

## Example 99

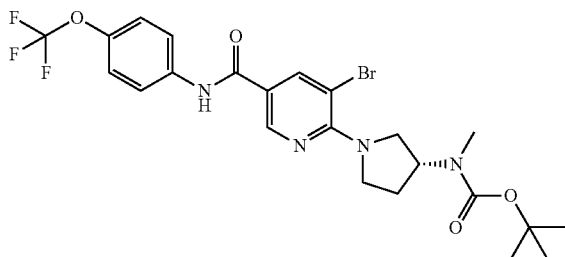
(R)-6-(3-(Methylamino)pyrrolidin-1-yl)-5-(pyrimidin-5-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide



## 159

The title compound was prepared in an analogous fashion to that described in Example 93 using (R)-tert-butyl (1-(3-bromo-5-((4-(trifluoromethoxy)phenyl)carbamoyl)pyridin-2-yl)pyrrolidin-3-yl)(methyl)carbamate (Stage 99.1) and pyrimidin-5-ylboronic acid. LC-MS (Condition 6)  $t_R$ =0.89 min,  $m/z$ =459.0  $[M+H]^+$ .

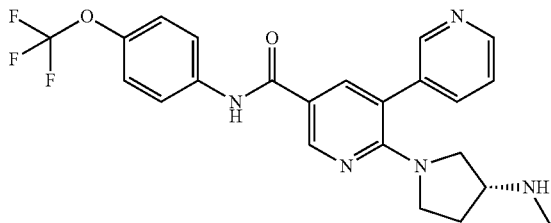
Stage 99.1 (R)-tert-Butyl (1-(3-bromo-5-((4-(trifluoromethoxy)phenyl)carbamoyl)pyridin-2-yl)pyrrolidin-3-yl)(methyl)carbamate



The title compound was prepared in an analogous fashion to that in Stage 93.1 using 5-bromo-6-chloro-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 12.2) and (R)-tert-butyl methyl(pyrrolidin-3-yl)carbamate. LC-MS (Condition 6)  $t_R$ =1.59 min,  $m/z$ =559.0/561.0  $[M+H]^+$ ,  $m/z$ =502.9/504.9  $[M+H-H_2C=C(CH_3)_2]$ .

## Example 100

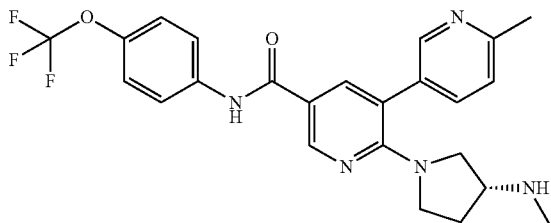
(R)-2-(3-(Methylamino)pyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)-[3,3'-bipyridine]-5-carboxamide



The title compound was prepared in an analogous fashion to that described in Example 93 using (R)-tert-butyl (1-(3-bromo-5-((4-(trifluoromethoxy)phenyl)carbamoyl)pyridin-2-yl)pyrrolidin-3-yl)(methyl)carbamate (Stage 99.1) and pyridin-3-ylboronic acid. LC-MS (Condition 6)  $t_R$ =0.8 min,  $m/z$ =458.0  $[M+H]^+$ .

## Example 101

(R)-6'-Methyl-2-(3-(methylamino)pyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)-[3,3'-bipyridine]-5-carboxamide

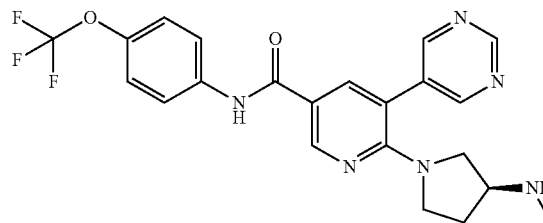


## 160

The title compound was prepared in an analogous fashion to that described in Example 93 using (R)-tert-butyl (1-(3-bromo-5-((4-(trifluoromethoxy)phenyl)carbamoyl)pyridin-2-yl)pyrrolidin-3-yl)(methyl)carbamate (Stage 99.1) and (6-methylpyridin-3-yl)boronic acid. LC-MS (Condition 6)  $t_R$ =0.81 min,  $m/z$ =472.0  $[M+H]^+$ .

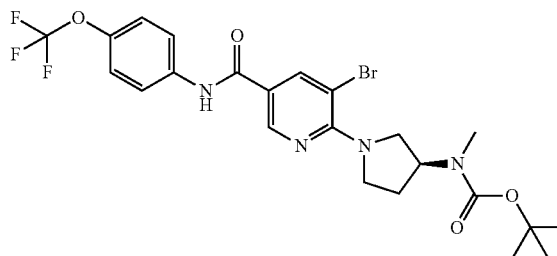
## Example 102

(S)-6-(3-(Methylamino)pyrrolidin-1-yl)-5-(pyrimidin-5-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide



The title compound was prepared in an analogous fashion to that described in Example 93 using (S)-tert-butyl (1-(3-bromo-5-((4-(trifluoromethoxy)phenyl)carbamoyl)pyridin-2-yl)pyrrolidin-3-yl)(methyl)carbamate (Stage 102.1) and pyrimidin-5-ylboronic acid. LC-MS (Condition 6)  $t_R$ =0.89 min,  $m/z$ =459.0  $[M+H]^+$ .

Stage 102.1 (S)-tert-Butyl (1-(3-bromo-5-((4-(trifluoromethoxy)phenyl)carbamoyl)pyridin-2-yl)pyrrolidin-3-yl)(methyl)carbamate

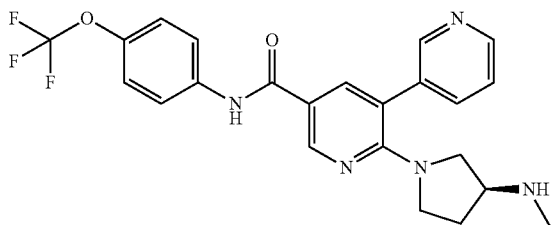


The title compound was prepared in an analogous fashion to that described in Stage 93.1 using 5-bromo-6-chloro-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 12.2) and (S)-tert-butyl methyl(pyrrolidin-3-yl)carbamate. LC-MS (Condition 6)  $t_R$ =1.59 min,  $m/z$ =558.8/560.8  $[M+H]^+$ ,  $m/z$ =502.9/504.9  $[M+H-H_2C=C(CH_3)_2]$ .

## 161

## Example 103

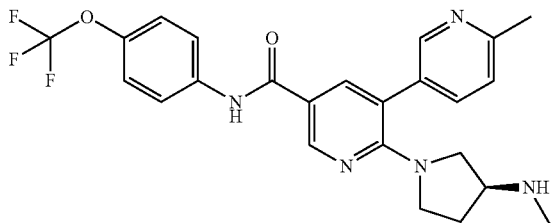
(S)-2-(3-(Methylamino)pyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)-[3,3'-bipyridine]-5-carboxamide



The title compound was prepared in an analogous fashion to that described in Example 93 using (S)-tert-butyl (1-(3-bromo-5-((4-(trifluoromethoxy)phenyl)carbamoyl)pyridin-2-yl)pyrrolidin-3-yl)methyl carbamate (Stage 102.1) and pyridin-3-ylboronic acid. LC-MS (Condition 6)  $t_R=0.8$  min,  $m/z=458.0$   $[M+H]^+$ .

## Example 104

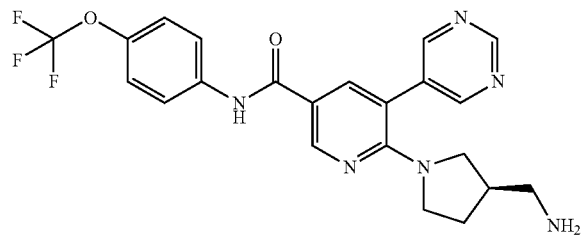
(S)-6'-Methyl-2-(3-(methylamino)pyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)-[3,3'-bipyridine]-5-carboxamide



The title compound was prepared in an analogous fashion to that described in Example 93 using (S)-tert-butyl (1-(3-bromo-5-((4-(trifluoromethoxy)phenyl)carbamoyl)pyridin-2-yl)pyrrolidin-3-yl)methyl carbamate (Stage 102.1) and (6-methylpyridin-3-yl)boronic acid. LC-MS (Condition 6)  $t_R=0.8$  min,  $m/z=472.0$   $[M+H]^+$ .

## Example 105

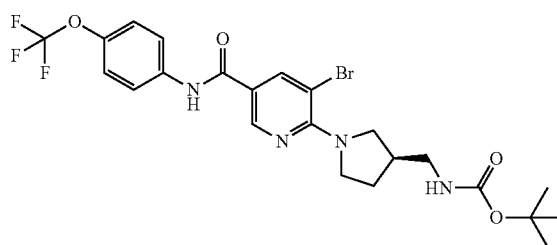
(R)-6-(3-(Aminomethyl)pyrrolidin-1-yl)-5-(pyrimidin-5-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide



## 162

The title compound was prepared in an analogous fashion to that described in Example 93 using (R)-tert-butyl ((1-(3-bromo-5-((4-(trifluoromethoxy)phenyl)carbamoyl)pyridin-2-yl)pyrrolidin-3-yl)methyl)carbamate (Stage 105.1) and pyrimidin-5-ylboronic acid. LC-MS (Condition 6)  $t_R=0.86$  min,  $m/z=459.0$   $[M+H]^+$ .

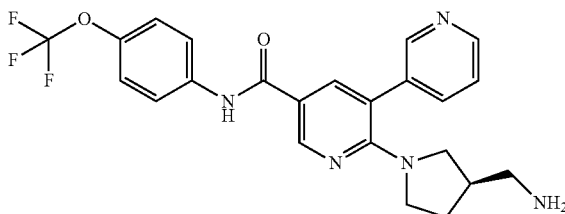
Stage 105.1 (R)-tert-Butyl ((1-(3-bromo-5-((4-(trifluoromethoxy)phenyl)carbamoyl)pyridin-2-yl)pyrrolidin-3-yl)methyl)carbamate



The title compound was prepared in an analogous fashion to that described in Stage 93.1 using 5-bromo-6-chloro-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 12.2) and (S)-tert-butyl (pyrrolidin-3-ylmethyl)carbamate. LC-MS (Condition 6)  $t_R=2.7$  min,  $m/z=559.0/561.0$   $[M+H]^+$ ,  $m/z=581.0$   $[M+Na]^+$ .

## Example 106

(R)-2-(3-(Aminomethyl)pyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)-[3,3'-bipyridine]-5-carboxamide

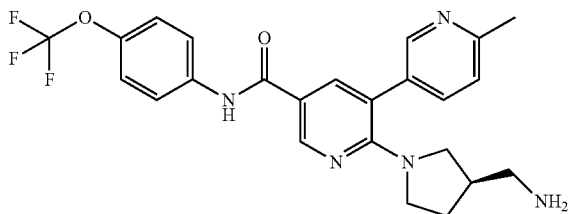


The title compound was prepared in an analogous fashion to that described in Example 93 using (R)-tert-butyl ((1-(3-bromo-5-((4-(trifluoromethoxy)phenyl)carbamoyl)pyridin-2-yl)pyrrolidin-3-yl)methyl)carbamate (Stage 105.1) and pyridin-3-ylboronic acid. LC-MS (Condition 6)  $t_R=0.8$  min,  $m/z=458.0$   $[M+H]^+$ .

## 163

## Example 107

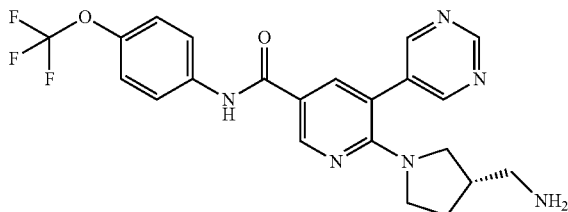
(R)-2-(3-(Aminomethyl)pyrrolidin-1-yl)-6'-methyl-N-(4-(trifluoromethoxy)phenyl)-[3,3'-bipyridine]-5-carboxamide



The title compound was prepared in an analogous fashion to that described in Example 93 using (R)-tert-butyl ((1-(3-bromo-5-((4-(trifluoromethoxy)phenyl)carbamoyl)pyridin-2-yl)pyrrolidin-3-yl)methyl)carbamate (Stage 105.1) and (6-methylpyridin-3-yl)boronic acid. LC-MS (Condition 6)  $t_R=0.81$  min,  $m/z=472.0$   $[M+H]^+$ .

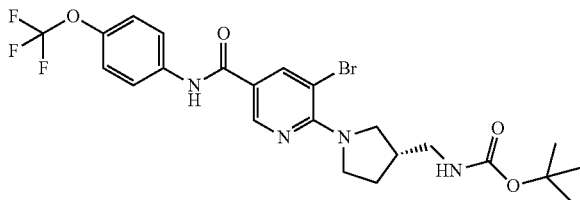
## Example 108

(S)-6-(3-(Aminomethyl)pyrrolidin-1-yl)-5-(pyrimidin-5-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide



The title compound was prepared in an analogous fashion to that described in Example 93 using (S)-tert-butyl ((1-(3-bromo-5-((4-(trifluoromethoxy)phenyl)carbamoyl)pyridin-2-yl)pyrrolidin-3-yl)methyl)carbamate (Stage 108.1) and pyrimidin-5-ylboronic acid. LC-MS (Condition 6)  $t_R=0.87$  min,  $m/z=459.0$   $[M+H]^+$ .

Stage 108.1 (S)-tert-Butyl ((1-(3-bromo-5-((4-(trifluoromethoxy)phenyl)carbamoyl)pyridin-2-yl)pyrrolidin-3-yl)methyl)carbamate



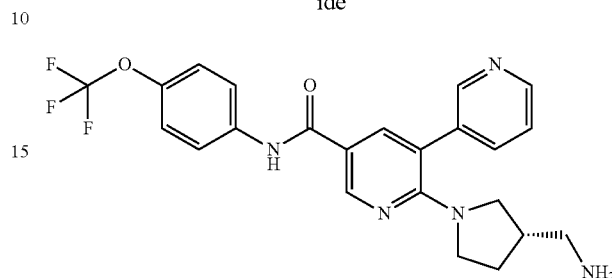
The title compound was prepared in an analogous fashion to that described in Stage 93.1 using 5-bromo-6-chloro-N-(4-

## 164

## Example 109

(trifluoromethoxy)phenyl)nicotinamide (Stage 12.2) and (R)-tert-butyl (pyrrolidin-3-ylmethyl)carbamate. LC-MS (Condition 6)  $t_R=1.46$  min,  $m/z=558.9$   $[M+H]^+$ ,  $m/z=581.0$   $[M+Na]^+$ .

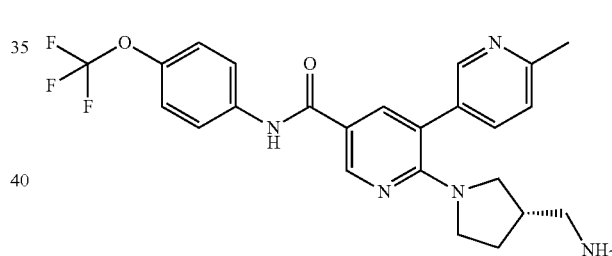
(S)-2-(3-(Aminomethyl)pyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)-[3,3'-bipyridine]-5-carboxamide



The title compound was prepared in an analogous fashion to that described in Example 93 using (S)-tert-butyl ((1-(3-bromo-5-((4-(trifluoromethoxy)phenyl)carbamoyl)pyridin-2-yl)pyrrolidin-3-yl)methyl)carbamate (Stage 108.1) and pyridin-3-ylboronic acid. LC-MS (Condition 6)  $t_R=0.8$  min,  $m/z=458.0$   $[M+H]^+$ .

## Example 110

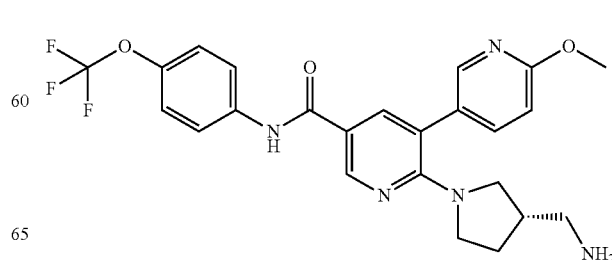
(S)-2-(3-(Aminomethyl)pyrrolidin-1-yl)-6'-methyl-N-(4-(trifluoromethoxy)phenyl)-[3,3'-bipyridine]-5-carboxamide



The title compound was prepared in an analogous fashion to that described in Example 93 using (S)-tert-butyl ((1-(3-bromo-5-((4-(trifluoromethoxy)phenyl)carbamoyl)pyridin-2-yl)pyrrolidin-3-yl)methyl)carbamate (Stage 108.1) and (6-methylpyridin-3-yl)boronic acid. LC-MS (Condition 6)  $t_R=0.79$  min,  $m/z=472.0$   $[M+H]^+$ .

## Example 111

(S)-2-(3-(Aminomethyl)pyrrolidin-1-yl)-6'-methoxy-N-(4-(trifluoromethoxy)phenyl)-[3,3'-bipyridine]-5-carboxamide

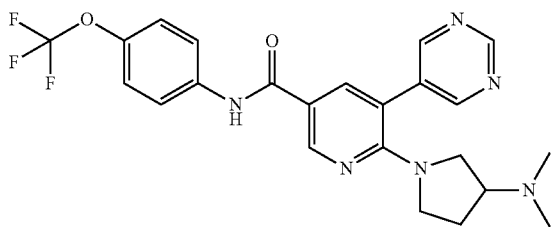


## 165

The title compound was prepared in an analogous fashion to that described in Example 93 using (S)-tert-butyl ((1-(3-bromo-5-((4-(trifluoromethoxy)phenyl)carbamoyl)pyridin-2-yl)pyrrolidin-3-yl)methyl)carbamate (Stage 108.1) and (6-methoxypyridin-3-yl)boronic acid. LC-MS (Condition 6)  $t_R=0.92$  min,  $m/z=488.0$   $[M+H]^+$ .

## Example 112

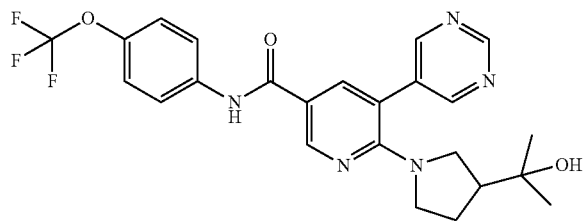
6-(3-(Dimethylamino)pyrrolidin-1-yl)-5-(pyrimidin-5-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide



The title compound was prepared in an analogous fashion to that described in Example 36 using 5-bromo-6-chloro-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 12.2) and pyrimidin-5-ylboronic acid to afford a white solid. UPLC-MS (condition 1)  $t_R=1.59$  min,  $m/z=473.1$   $[M+H]^+$ ,  $m/z=471.1$   $[M-H]^-$ ;  $^1H$ -NMR (400 MHz, DMSO- $d_6$ )  $\delta$  ppm 1.95-2.11 (m, 1H) 2.17-2.31 (m, 1H) 2.73-2.86 (m, 6H) 2.98-3.10 (m, 1H) 3.09-3.19 (m, 1H) 3.58 (d,  $J=6.6$  Hz, 1H) 3.70-3.77 (m, 1H) 3.80-3.89 (m, 1H) 7.37 (d,  $J=8.6$  Hz, 2H) 7.85 (d,  $J=4.9$  Hz, 2H) 8.19 (d,  $J=2.4$  Hz, 1H) 8.82 (d,  $J=2.4$  Hz, 1H) 8.93 (s, 2H) 9.23 (s, 1H) 9.83 (br. s, 1H)(NH+) 10.26 (s, 1H).

## Example 113

6-(3-(2-Hydroxypropan-2-yl)pyrrolidin-1-yl)-5-(pyrimidin-5-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide

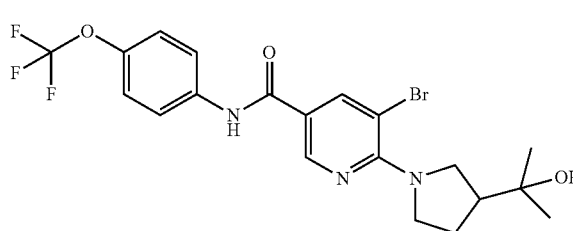


5-Bromo-6-(3-(2-hydroxypropan-2-yl)pyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 113.1, 98 mg, 0.2 mmol) and pyrimidin-5-ylboronic acid (49.6 mg, 0.4 mmol) were dissolved in DME (0.8 mL) and EtOH (0.12 mL). A solution of 2 M  $NaHCO_3$  (0.3 mL, 0.6 mmol) was added, the RM was flushed with argon, then  $Pd(PPh_3)_2Cl_2$  (14.0 mg, 0.02 mmol) was added. The RM was stirred under argon at  $95^\circ C$ . for 2 h in a sealed pressure safe tube. After cooling at RT, the RM was dissolved in EtOAc, washed with brine, dried over  $Na_2SO_4$  and evaporated to dryness under

## 166

reduced pressure. The crude product was purified by flash chromatography (RediSep® Silica gel column, DCM/MeOH from 2% to 5% MeOH) and treated with Si-Thiol (80 mg) in MeOH to afford the title compound as a white solid. HPLC (Condition 4)  $t_R=4.94$  min, UPLC-MS (Condition 3)  $t_R=1.01$  min,  $m/z=532.3$   $[M+H]^+$ ;  $^1H$ -NMR (400 MHz, DMSO- $d_6$ )  $\delta$  ppm 0.90-1.08 (m, 6H) 1.58-1.83 (m, 2H) 1.99-2.15 (m, 1H) 3.05-3.23 (m, 3H) 3.25-3.35 (m, 1H) 4.29 (s, 1H) 7.33 (d,  $J=8.60$  Hz, 2H) 7.75-7.87 (m, 2H) 8.07 (d,  $J=2.35$  Hz, 1H) 8.77 (d,  $J=2.35$  Hz, 1H) 8.87 (s, 2H) 9.17 (s, 1H) 10.14 (s, 1H).

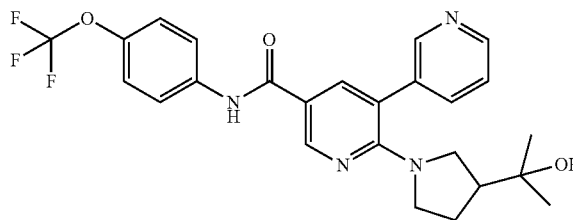
Stage 113.1 5-Bromo-6-(3-(2-hydroxypropan-2-yl)pyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide



The title compound was prepared in an analogous fashion to that described in Stage 33.1 using 5-bromo-6-chloro-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 12.2) and 3-(1-hydroxy-1-methyl-ethyl)-pyrrolidine (US2010160280) and was obtained as an off-white solid. HPLC (Condition 4)  $t_R=6.11$  min, UPLC-MS (Condition 7)  $m/z=490.1$   $[M+H]^+$ .

## Example 114

2-(3-(2-Hydroxypropan-2-yl)pyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)-[3,3'-bipyridine]-5-carboxamide



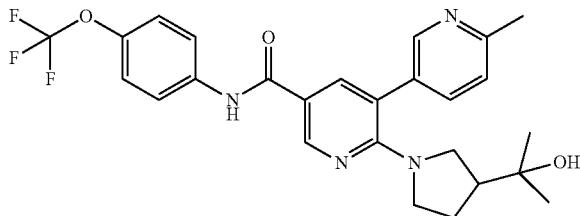
The title compound was prepared in an analogous fashion to that described in Example 113 using 5-bromo-6-(3-(2-hydroxypropan-2-yl)pyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 113.1) and pyridin-3-ylboronic acid to afford a white solid. HPLC (Condition 4)  $t_R=4.68$  min, UPLC-MS (Condition 7)  $m/z=487.2$   $[M+H]^+$ ;  $^1H$ -NMR (400 MHz, DMSO- $d_6$ )  $\delta$  ppm 0.87-1.10 (m, 6H) 1.53-1.80 (m, 2H) 1.96-2.12 (m, 1H) 3.00-3.20 (m, 3H) 3.24-3.33 (m, 1H) 4.25 (s, 1H) 7.32 (d,  $J=8.99$  Hz, 2H) 7.46 (dd,  $J=7.82, 5.08$  Hz, 1H) 7.74-7.89 (m, 3H) 8.00 (d,  $J=2.35$  Hz,

## 167

1H) 8.55 (dd, J=4.69, 1.56 Hz, 1H) 8.61 (d, J=1.56 Hz, 1H) 8.74 (d, J=2.35 Hz, 1H) 10.14 (s, 1H).

## Example 115

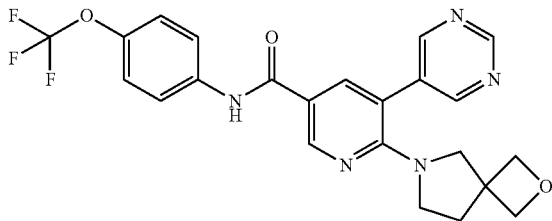
2-(3-(2-Hydroxypropan-2-yl)pyrrolidin-1-yl)-6'-methyl-N-(4-(trifluoromethoxy)phenyl)-[3,3'-bipyridine]-5-carboxamide



The title compound was prepared in an analogous fashion to that described in Example 113 using 5-bromo-6-(3-(2-hydroxypropan-2-yl)pyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 113.1) and (6-methylpyridin-3-yl)boronic acid to afford an off-white amorphous solid. HPLC (Condition 4)  $t_R$ =4.38 min, UPLC-MS (Condition 7)  $m/z$ =501.2 [M+H]<sup>+</sup>; <sup>1</sup>H-NMR (400 MHz, DMSO- $d_6$ )  $\delta$  ppm 1.00 (d, J=16.03 Hz, 6H) 1.55-1.80 (m, 2H) 1.95-2.12 (m, 1H) 2.48 (s, 3H) 2.99-3.20 (m, 3H) 3.22-3.35 (m, 1H) 4.26 (s, 1H) 7.32 (dd, J=8.21, 5.86 Hz, 3H) 7.67 (dd, J=7.82, 2.35 Hz, 1H) 7.78-7.89 (m, 2H) 7.96 (d, J=2.35 Hz, 1H) 8.47 (d, J=2.35 Hz, 1H) 8.72 (d, J=2.35 Hz, 1H) 10.13 (s, 1H).

## Example 116

5-(Pyrimidin-5-yl)-6-(2-oxa-6-azaspiro[3.4]octan-6-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide

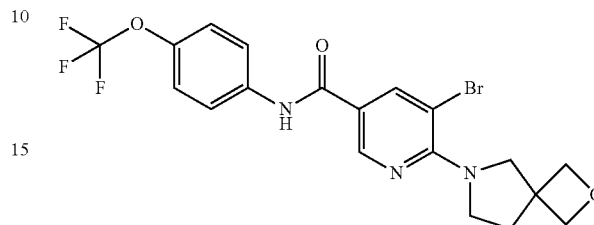


The title compound was prepared in an analogous fashion to that described in Example 86 using 5-bromo-6-(2-oxa-6-azaspiro[3.4]octan-6-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 116.1) and pyrimidin-5-ylboronic acid to afford a white solid. UPLC-MS (condition 1)  $t_R$ =2.35 min,  $m/z$ =472.0 [M+H]<sup>+</sup>,  $m/z$ =470.0 [M-H]<sup>-</sup>; <sup>1</sup>H-NMR (400 MHz, DMSO- $d_6$ )  $\delta$  ppm 2.00-2.15 (m, 2H) 3.11 (t, J=6.72 Hz, 2H) 3.44 (s, 2H) 4.41-4.45 (m, 2H) 4.45-4.50 (m, 2H) 7.36 (d,

## 168

J=8.31 Hz, 2H) 7.85 (d, J=9.05 Hz, 2H) 8.11 (d, J=2.45 Hz, 1H) 8.79 (d, J=2.45 Hz, 1H) 8.90 (s, 2H) 9.20 (s, 1H) 10.19 (s, 1H).

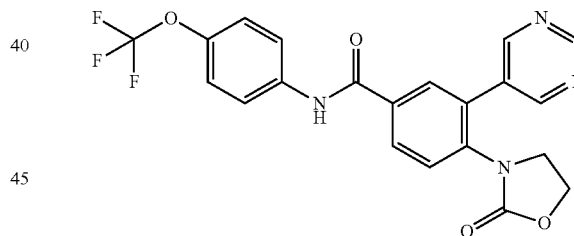
## 5 Stage 116.1 5-Bromo-6-(2-oxa-6-azaspiro[3.4]octan-6-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide



The title compound was prepared in an analogous fashion to that described in Stage 12.1 using 5-bromo-6-chloro-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Example 35) and 2-oxa-6-azaspiro[3.4]octane to afford white needles. UPLC-MS (condition 1)  $t_R$ =2.93 min,  $m/z$ =471.9/473.9 [M+H]<sup>+</sup>,  $m/z$ =469.9/471.9 [M-H]<sup>-</sup>; <sup>1</sup>H-NMR (400 MHz, DMSO- $d_6$ )  $\delta$  ppm 2.20 (t, J=6.85 Hz, 2H) 3.73 (t, J=6.97 Hz, 2H) 3.95 (s, 2H) 4.51 (d, J=5.87 Hz, 2H) 4.60 (d, J=5.87 Hz, 2H) 7.35 (d, J=8.31 Hz, 2H) 7.82-7.88 (m, 2H) 8.36 (d, J=2.20 Hz, 1H) 8.69 (d, J=1.96 Hz, 1H) 10.24 (s, 1H).

## Example 117

4-(2-Oxooxazolidin-3-yl)-3-(pyrimidin-5-yl)-N-(4-(trifluoromethoxy)phenyl)benzamide

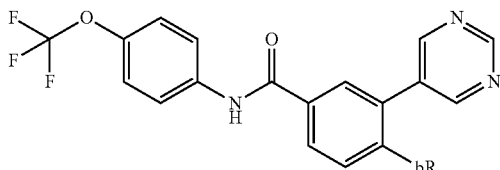


4-Bromo-3-(pyrimidin-5-yl)-N-(4-(trifluoromethoxy)phenyl)benzamide (Stage 117.1, 100 mg, 0.228 mmol), oxazolidin-2-one (79 mg, 0.913 mmol), copper iodide (4.35 mg, 0.023 mmol) and finely ground K<sub>3</sub>PO<sub>4</sub> (143 mg, 0.672 mmol) were added to a MW vial. The vial was sealed, evacuated/purged with argon and a solution of trans-N,N'-dimethylcyclohexane-1,2-diamine (7.20  $\mu$ L, 0.046 mmol) in dioxane (456  $\mu$ L) was added. The RM was then stirred at 110° C. for 20 hr. The RM was diluted with EtOAc (5 mL), washed with 1M HCl (20 mL) and extracted with EtOAc. The combined extracts were sequentially washed with NH<sub>4</sub>OH (32%)/NH<sub>4</sub>Cl (sat.) 1:5 (10 mL), and brine (10 mL), dried over Na<sub>2</sub>SO<sub>4</sub>, and the mixture was evaporated to dryness under reduced pressure. The crude product was purified by flash chromatography (RediSep® Silica gel column, 12 g, cyclohexane/EtOAc-EtOH+0.1% NH<sub>4</sub>OH (9:1), from 20% to 90% EtOAc-EtOH+0.1% NH<sub>4</sub>OH (9:1)). Second purification was

## 169

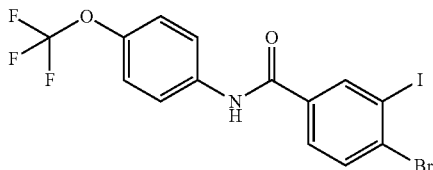
performed by preparative HPLC (Condition 13, from 5% to 100% in 14 min) afforded the title compound as a brown solid. UPLC-MS (condition 1)  $t_R$ =2.13 min,  $m/z$ =445.1  $[M+H]^+$ ,  $m/z$ =443.2  $[M-H]^-$ ;  $^1H$ -NMR (400 MHz, DMSO- $d_6$ )  $\delta$  ppm 4.03-4.21 (m, 2H) 4.32-4.49 (m, 2H) 7.39 (d,  $J$ =8.31 Hz, 2H) 7.72-7.83 (m, 1H) 7.84-7.93 (m, 2H) 8.06-8.17 (m, 2H) 8.96 (s, 2H) 9.22 (s, 1H) 10.49 (s, 1H).

Stage 117.1 4-Bromo-3-(pyrimidin-5-yl)-N-(4-(trifluoromethoxy)phenyl)-benzamide



4-Bromo-3-iodo-N-(4-(trifluoromethoxy)phenyl)benzamide (Stage 117.2, 3 g, 6.17 mmol), pyrimidin-5-ylboronic acid (841 mg, 6.79 mmol),  $Pd(PPh_3)_2Cl_2$  (217 mg, 0.309 mmol) and  $Na_2CO_3$  (1.963 g, 18.52 mmol) in a mixture of DME (17.28 mL), water (4.94 mL), EtOH (2.469 mL) was degassed and stirred at 80° C. for 23 h under argon. Additional pyrimidin-5-ylboronic acid (76 mg, 0.613 mmol) was added to the RM and stirring was continued for 5 h. The RM was treated with Si-Thiol (Silicycle, 1.27 mmol/g, 1.215 g, 1.543 mmol), filtered and the filtrate was evaporated off under reduced pressure to give a residue which was purified by flash chromatography (Silica gel column, 80 g, cyclohexane/EtOAc, from 10% to 45% EtOAc) to yield the title compound as a white crystalline solid. UPLC-MS (condition 1)  $t_R$ =2.80 min,  $m/z$ =437.9-439.9  $[M+H]^+$ ,  $m/z$ =436.0-438.0  $[M-H]^-$ .

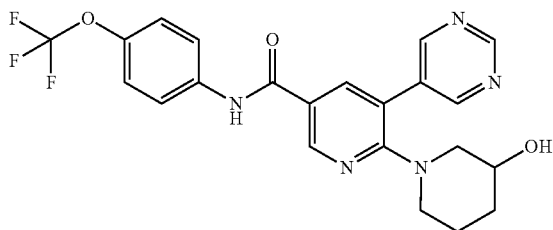
Stage 117.2 4-Bromo-3-iodo-N-(4-(trifluoromethoxy)phenyl)-benzamide



The title compound was prepared in an analogous fashion to that described in Stage 1.2 using 4-bromo-3-iodobenzoic acid and 4-(trifluoromethoxy)aniline to afford a white solid. UPLC-MS (condition 1)  $t_R$ =3.64 min,  $m/z$ =485.7  $[M+H]^+$ ,  $m/z$ =483.8  $[M-H]^-$ ; Br pattern.  $^1H$ -NMR (400 MHz, DMSO- $d_6$ )  $\delta$  ppm 7.38 (d,  $J$ =8.3 Hz, 2H) 7.82-7.93 (m, 4H) 8.47 (d,  $J$ =1.7 Hz, 1H) 10.52 (s, 1H).

## Example 118

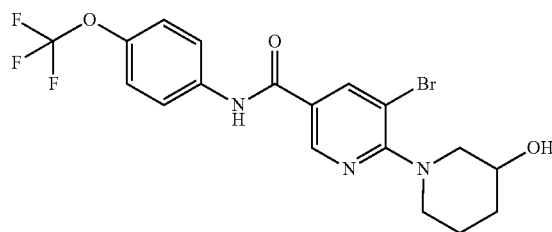
6-(3-Hydroxypiperidin-1-yl)-5-(pyrimidin-5-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide



## 170

5-Bromo-6-(3-hydroxypiperidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 118.1, 60 mg, 0.130 mmol), pyrimidin-5-ylboronic acid (24.2 mg, 0.196 mmol),  $Pd_2(dba)_3$  (2.388 mg, 2.61  $\mu$ mol), 2-dichlorohexylphosphino-2'-4'-6'-triisopropylbiphenyl (XPhos, 4.97 mg, 10.43  $\mu$ mol) and  $K_3PO_4$  (83 mg, 0.391 mmol) were added to a MW vial. The vial was sealed, evacuated/purged with argon, and BuOH was added. The RM was stirred at 100° C. for 16 h. The RM was diluted with THF (1 mL), treated with Si-Thiol (Silicycle, 1.44 mmol/g, 45.3 mg, 0.065 mmol), filtered and the filtrate was evaporated off under reduced pressure to give a residue which was purified by preparative HPLC (Condition 12, 25% for 0.2 min then 25% to 55% in 12 min) to yield the title compound as a white solid. UPLC-MS (condition 1)  $t_R$ =2.31 min,  $m/z$ =460.1-461.1  $[M+H]^+$ ,  $m/z$ =458.2-459.2  $[M-H]^-$ ;  $^1H$ -NMR (400 MHz, DMSO- $d_6$ )  $\delta$  ppm 1.21-1.39 (m, 2H) 1.56-1.65 (m, 1H) 1.77-1.86 (m, 1H) 2.63 (dd,  $J$ =11.86, 8.44 Hz, 1H) 2.75-2.84 (m, 1H) 3.25-3.38 (m, 1H) 3.43-3.55 (m, 2H) 4.74 (d,  $J$ =3.91 Hz, 1H) 7.37 (d,  $J$ =8.80 Hz, 2H) 7.86 (d,  $J$ =9.05 Hz, 2H) 8.19 (d,  $J$ =2.20 Hz, 1H) 8.80 (d,  $J$ =2.20 Hz, 1H) 9.08 (s, 2H) 9.21 (s, 1H) 10.30 (s, 1H).

Stage 118.1 5-Bromo-6-(3-hydroxypiperidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide

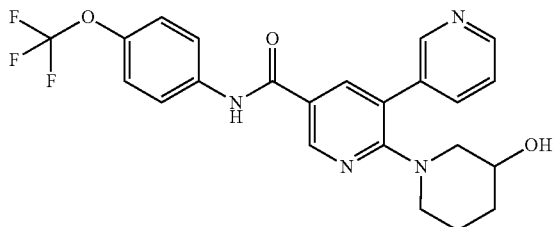


5-Bromo-6-chloro-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Example 35, 1 g, 2.53 mmol), 3-hydroxypiperidine (307 mg, 3.03 mmol) and DIPEA (883  $\mu$ L, 5.06 mmol) in iPrOH (2528  $\mu$ L) were added to a MW vial and subjected to MW irradiation at 140° C. for 60 min. The vial was cooled to RT and the RM was evaporated to dryness under reduced pressure, treated with 0.5 M HCl (25 mL) and extracted with EtOAc. The combined extracts were washed with HCl 0.5 M, brine, dried over  $MgSO_4$  and evaporated to dryness under reduced pressure. The crude product was purified by flash chromatography (Silica gel column, 24 g, cyclohexane/EtOAc-EtOH+0.1%  $NH_4OH$  (9:1)), from 15% to 60% EtOAc-EtOH+0.1%  $NH_4OH$  (9:1)) to afford the title compound as a white foam. UPLC-MS (condition 1)  $t_R$ =2.89 min,  $m/z$ =460.0-462.0  $[M+H]^+$ ,  $m/z$ =458.0-460.0  $[M-H]^-$ ;  $^1H$ -NMR (400 MHz, DMSO- $d_6$ )  $\delta$  ppm 1.27-1.45 (m, 1H) 1.46-1.66 (m, 1H) 1.73-1.87 (m, 1H) 1.89-2.01 (m, 1H) 2.74 (dd,  $J$ =12.23, 9.29 Hz, 1H) 2.92 (t,  $J$ =10.64 Hz, 1H) 3.56-3.70 (m, 1H) 3.70-3.81 (m, 1H) 3.91 (dd,  $J$ =12.10, 3.30 Hz, 1H) 4.87 (d,  $J$ =4.40 Hz, 1H) 7.36 (d,  $J$ =8.56 Hz, 2H) 7.85 (d,  $J$ =9.05 Hz, 2H) 8.42 (d,  $J$ =1.96 Hz, 1H) 8.76 (d,  $J$ =1.96 Hz, 1H) 10.37 (s, 1H).

## 171

## Example 119

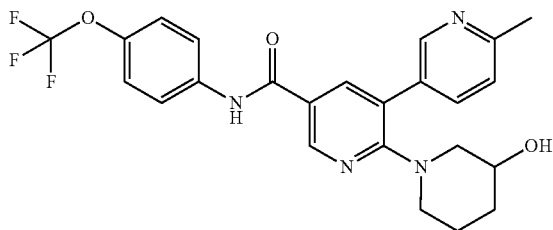
2-(3-Hydroxypiperidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)-[3,3'-bipyridine]-5-carboxamide



The title compound was prepared in an analogous fashion to that described in Example 118 using 5-bromo-6-(3-hydroxypiperidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 118.1) and pyridin-3-ylboronic acid to afford a white solid. UPLC-MS (condition 1)  $t_R$ =2.06 min,  $m/z$ =459.1-460.1  $[M+H]^+$ ,  $m/z$ =457.2-458.2  $[M-H]^-$ ;  $^1H$ -NMR (400 MHz, DMSO- $d_6$ )  $\delta$  ppm 1.20-1.38 (m, 2H) 1.53-1.61 (m, 1H) 1.79-1.86 (m, 1H) 2.59 (dd,  $J$ =12.23, 9.05 Hz, 1H) 2.69-2.78 (m, 1H) 3.35-3.41 (m, 1H) 3.43-3.50 (m, 1H) 3.56-3.62 (m, 1H) 4.73 (d,  $J$ =4.40 Hz, 1H) 7.37 (d,  $J$ =8.80 Hz, 2H) 7.50-7.54 (m, 1H) 7.86 (d,  $J$ =9.05 Hz, 2H) 8.02 (dt,  $J$ =8.01, 1.86 Hz, 1H) 8.11 (d,  $J$ =2.45 Hz, 1H) 8.57-8.61 (m, 1H) 8.77 (d,  $J$ =2.20 Hz, 1H) 8.81 (d,  $J$ =1.71 Hz, 1H) 10.30 (s, 1H).

## Example 120

2-(3-Hydroxypiperidin-1-yl)-6'-methyl-N-(4-(trifluoromethoxy)phenyl)-[3,3'-bipyridine]-5-carboxamide



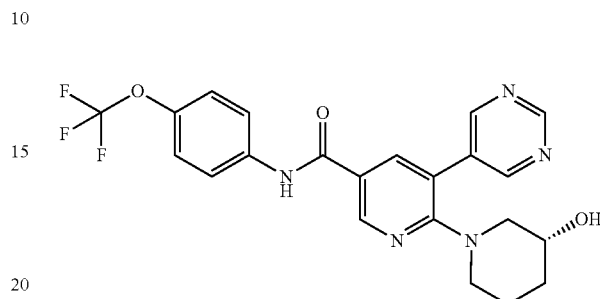
The title compound was prepared in an analogous fashion to that described in Example 118 using 5-bromo-6-(3-hydroxypiperidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 118.1) and (6-methylpyridin-3-yl)boronic acid to afford a white solid. UPLC-MS (condition 1)  $t_R$ =1.88 min,  $m/z$ =473.1-474.1  $[M+H]^+$ ,  $m/z$ =471.1-472.1  $[M-H]^-$ ;  $^1H$ -NMR (400 MHz, DMSO- $d_6$ )  $\delta$  ppm 1.19-1.38 (m, 2H) 1.53-1.61 (m, 1H) 1.79-1.86 (m, 1H) 2.53 (s, 3H) 2.57 (dd,  $J$ =12.10, 9.17 Hz, 1H) 2.72 (t,  $J$ =10.51 Hz, 1H) 3.35-3.41 (m, 1H) 3.42-3.51 (m, 1H) 3.56-3.63 (m, 1H) 4.73 (d,  $J$ =4.40 Hz, 1H) 7.34-7.39 (m, 3H) 7.86 (d,  $J$ =8.80 Hz, 2H) 7.90 (dd,

## 172

$J$ =8.07, 2.20 Hz, 1H) 8.06 (d,  $J$ =2.20 Hz, 1H) 8.67 (d,  $J$ =1.96 Hz, 1H) 8.74 (d,  $J$ =2.20 Hz, 1H) 10.29 (s, 1H).

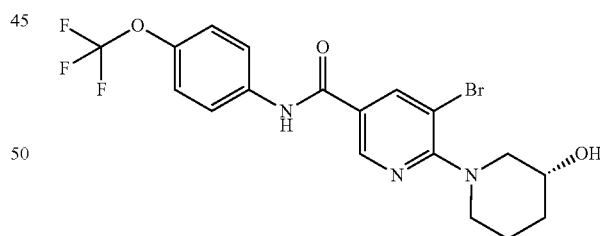
## Example 121

(R)-6-(3-Hydroxypiperidin-1-yl)-5-(pyrimidin-5-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide



The title compound was prepared in an analogous fashion to that described in Example 118 using (R)-5-bromo-6-(3-hydroxypiperidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 121.1) and pyrimidin-5-ylboronic acid to afford a white solid. UPLC-MS (condition 1)  $t_R$ =2.21 min,  $m/z$ =460.01  $[M+H]^+$ ,  $m/z$ =458.2  $[M-H]^-$ ;  $^1H$ -NMR (400 MHz, DMSO- $d_6$ )  $\delta$  ppm 1.21-1.39 (m, 2H) 1.56-1.65 (m, 1H) 1.77-1.86 (m, 1H) 2.63 (dd,  $J$ =11.86, 8.44 Hz, 1H) 2.75-2.84 (m, 1H) 3.35-3.38 (m, 1H) 3.43-3.49 (m, 1H) 3.49-3.55 (m, 1H) 4.74 (s, 1H) 7.37 (d,  $J$ =8.56 Hz, 2H) 7.83-7.89 (m, 2H) 8.19 (d,  $J$ =2.45 Hz, 1H) 8.80 (d,  $J$ =2.45 Hz, 2H) 9.08 (s, 1H) 9.21 (s, 1H) 10.30 (s, 1H).

Stage 121.1 (R)-5-Bromo-6-(3-hydroxypiperidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide



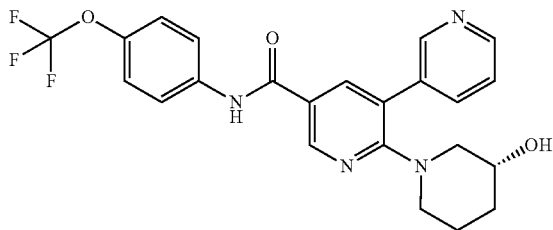
The title compound was prepared in an analogous fashion to that described in Stage 12.1 using 5-bromo-6-chloro-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Example 35) and (R)-(+)-3-hydroxypiperidine hydrochloride to afford a brown oil. UPLC-MS (condition 1)  $t_R$ =3.38 min,  $m/z$ =460.0-462.0  $[M+H]^+$ ,  $m/z$ =458.0-461.0  $[M-H]^-$ ;  $^1H$ -NMR (400 MHz, DMSO- $d_6$ )  $\delta$  ppm 1.28-1.41 (m, 1H) 1.49-1.63 (m, 1H) 1.75-1.85 (m, 1H) 1.90-1.98 (m, 1H) 2.73 (dd,  $J$ =12.23, 9.29 Hz, 1H) 2.87-2.96 (m, 1H) 3.56-3.69 (m, 1H) 3.75 (d,  $J$ =12.72 Hz, 1H) 3.91 (dd,  $J$ =12.10, 3.55 Hz, 1H) 4.88 (s, 1H) 7.36 (d,

## 173

J=8.80 Hz, 2H) 7.82-7.89 (m, 2H) 8.42 (d, J=2.20 Hz, 1H) 8.76 (d, J=2.20 Hz, 1H) 10.37 (s, 1H).

## Example 122

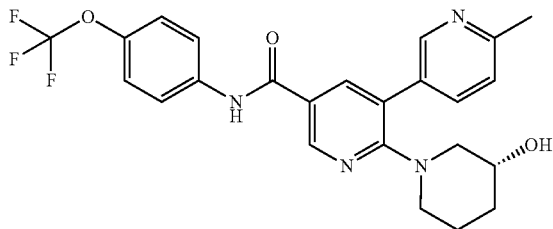
(R)-2-(3-Hydroxypiperidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)-[3,3'-bipyridine]-5-carboxamide



The title compound was prepared in an analogous fashion to that described in Example 118 using (R)-5-bromo-6-(3-hydroxypiperidin-1-yl)-N-(4-(trifluoromethoxy)phenyl) nicotinamide (Stage 121.1) and pyridin-3-ylboronic acid to afford a white solid. UPLC-MS (condition 1)  $t_R$ =1.98 min,  $m/z$ =459.1 [M+H]<sup>+</sup>,  $m/z$ =457.2 [M-H]<sup>-</sup>; <sup>1</sup>H-NMR (400 MHz, DMSO- $d_6$ )  $\delta$  ppm 1.18-1.38 (m, 2H) 1.52-1.61 (m, 1H) 1.76-1.87 (m, 1H) 2.58 (dd, J=12.23, 9.05 Hz, 1H) 2.68-2.78 (m, 1H) 3.34-3.41 (m, 1H) 3.41-3.51 (m, 1H) 3.54-3.62 (m, 1H) 4.72 (d, J=3.67 Hz, 1H) 7.36 (d, J=8.80 Hz, 2H) 7.51 (dd, J=7.95, 4.77 Hz, 1H) 7.83-7.89 (m, 2H) 7.99-8.04 (m, 1H) 8.10 (d, J=2.20 Hz, 1H) 8.58 (d, J=4.65 Hz, 1H) 8.76 (d, J=2.20 Hz, 1H) 8.79-8.83 (m, 1H) 10.29 (s, 1H).

## Example 123

(R)-2-(3-Hydroxypiperidin-1-yl)-6'-methyl-N-(4-(trifluoromethoxy)phenyl)-[3,3'-bipyridine]-5-carboxamide



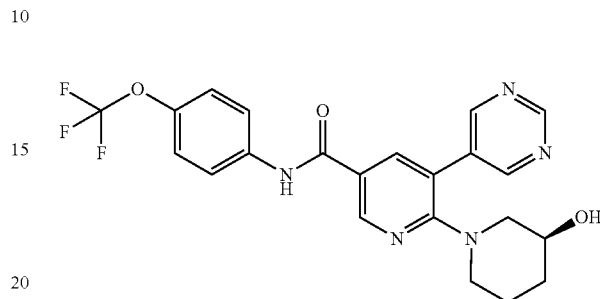
The title compound was prepared in an analogous fashion to that described in Example 118 using (R)-5-bromo-6-(3-hydroxypiperidin-1-yl)-N-(4-(trifluoromethoxy)phenyl) nicotinamide (Stage 121.1) and (6-methylpyridin-3-yl)boronic acid to afford a white solid. UPLC-MS (condition 1)  $t_R$ =2.28 min,  $m/z$ =473.1 [M+H]<sup>+</sup>,  $m/z$ =471.2 [M-H]<sup>-</sup>; <sup>1</sup>H-NMR (400 MHz, DMSO- $d_6$ )  $\delta$  ppm 1.18-1.39 (m, 2H) 1.53-1.62 (m, 1H) 1.77-1.86 (m, 1H) 2.54 (s, 3H) 2.55-2.62 (m, 1H) 2.68-2.77 (m, 1H) 3.42-3.51 (m, 2H) 3.55-3.63 (m, 1H) 4.72 (s, 1H) 7.36 (d, J=9.05 Hz, 2H) 7.40 (d, J=8.07 Hz,

## 174

1H) 7.83-7.88 (m, 2H) 7.92-7.98 (m, 1H) 8.07 (d, J=1.96 Hz, 1H) 8.67-8.72 (m, 1H) 8.75 (d, J=2.20 Hz, 1H) 10.29 (s, 1H).

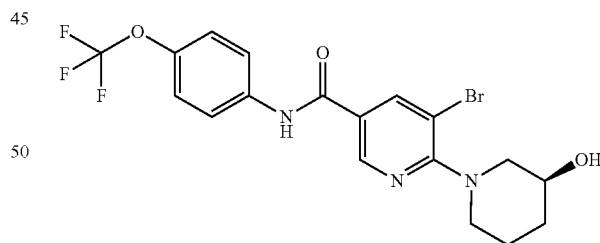
## Example 124

(S)-6-(3-Hydroxypiperidin-1-yl)-5-(pyrimidin-5-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide



The title compound was prepared in an analogous fashion to that described in Example 118 using (S)-5-bromo-6-(3-hydroxypiperidin-1-yl)-N-(4-(trifluoromethoxy)phenyl) nicotinamide (Stage 124.1) and pyrimidin-5-ylboronic acid to afford a white solid. UPLC-MS (condition 1)  $t_R$ =2.22 min,  $m/z$ =460.0 [M+H]<sup>+</sup>,  $m/z$ =458.1 [M-H]<sup>-</sup>; <sup>1</sup>H-NMR (400 MHz, DMSO- $d_6$ )  $\delta$  ppm 1.21-1.39 (m, 2H) 1.56-1.65 (m, 1H) 1.77-1.86 (m, 1H) 2.63 (dd, J=11.86, 8.19 Hz, 1H) 2.75-2.84 (m, 1H) 3.35-3.39 (m, 1H) 3.43-3.49 (m, 1H) 3.49-3.55 (m, 1H) 4.74 (s, 1H) 7.37 (d, J=8.31 Hz, 2H) 7.83-7.89 (m, 2H) 8.19 (d, J=2.20 Hz, 1H) 8.80 (d, J=2.20 Hz, 1H) 9.08 (s, 2H) 9.21 (s, 1H) 10.30 (s, 1H).

Stage 124.1 (S)-5-Bromo-6-(3-hydroxypiperidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide



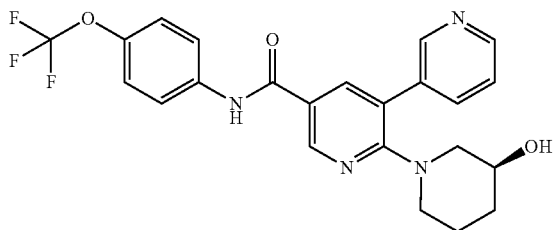
The title compound was prepared in an analogous fashion to that described in Stage 12.1 using 5-bromo-6-chloro-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Example 35) and (S)-3-hydroxypiperidine hydrochloride to afford a brown oil. UPLC-MS (condition 1)  $t_R$ =3.36 min,  $m/z$ =460.0-462.0,  $m/z$ =458.0-460.1; <sup>1</sup>H-NMR (400 MHz, DMSO- $d_6$ )  $\delta$  ppm 1.28-1.41 (m, 1H) 1.49-1.63 (m, 1H) 1.75-1.84 (m, 1H) 1.90-1.97 (m, 1H) 2.73 (dd, J=12.10, 9.17 Hz, 1H) 2.87-2.96 (m, 1H) 3.59-3.68 (m, 1H) 3.75 (d, J=12.72 Hz, 1H) 3.87-3.95

## 175

(m, 1H) 4.88 (s, 1H) 7.36 (d, J=8.80 Hz, 2H) 7.82-7.88 (m, 2H) 8.42 (d, J=1.96 Hz, 1H) 8.76 (d, J=1.96 Hz, 1H) 10.37 (s, 1H).

## Example 125

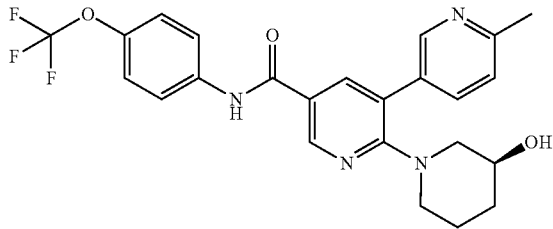
(S)-2-(3-Hydroxypiperidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)-[3,3'-bipyridine]-5-carboxamide



The title compound was prepared in an analogous fashion to that described in Example 118 using (S)-5-bromo-6-(3-hydroxypiperidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 124.1) and pyridin-3-ylboronic acid to afford a white solid. UPLC-MS (condition 1)  $t_R$ =1.97 min,  $m/z$ =459.1 [M+H]<sup>+</sup>,  $m/z$ =457.1 [M-H]<sup>-</sup>; <sup>1</sup>H-NMR (400 MHz, DMSO-*d*<sub>6</sub>) δ ppm 1.19-1.37 (m, 2H) 1.53-1.61 (m, 1H) 1.82 (d, J=8.56 Hz, 1H) 2.58 (dd, J=12.23, 9.05 Hz, 1H) 2.69-2.78 (m, 1H) 3.34-3.40 (m, 1H) 3.41-3.51 (m, 1H) 3.55-3.62 (m, 1H) 4.73 (d, J=4.40 Hz, 1H) 7.36 (d, J=8.56 Hz, 2H) 7.52 (dd, J=7.95, 4.77 Hz, 1H) 7.83-7.89 (m, 2H) 8.02 (dt, J=7.82, 1.83 Hz, 1H) 8.10 (d, J=2.20 Hz, 1H) 8.59 (dd, J=4.65, 1.22 Hz, 1H) 8.76 (d, J=2.20 Hz, 1H) 8.81 (d, J=1.71 Hz, 1H) 10.29 (s, 1H).

## Example 126

(S)-2-(3-Hydroxypiperidin-1-yl)-6'-methyl-N-(4-(trifluoromethoxy)phenyl)-[3,3'-bipyridine]-5-carboxamide



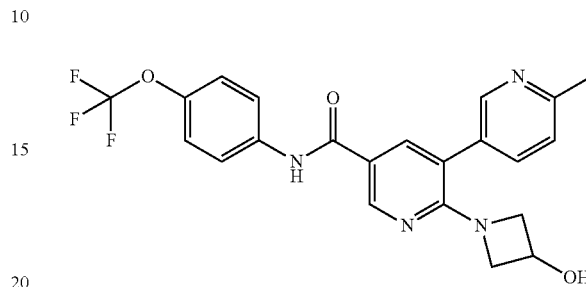
The title compound was prepared in an analogous fashion to that described in Example 118 using (S)-5-bromo-6-(3-hydroxypiperidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 124.1) and (6-methylpyridin-3-yl)boronic acid to afford a white solid. UPLC-MS (condition 1)  $t_R$ =2.16 min,  $m/z$ =473.1 [M+H]<sup>+</sup>,  $m/z$ =471.1 [M-H]<sup>-</sup>; <sup>1</sup>H-NMR (400 MHz, DMSO-*d*<sub>6</sub>) δ ppm 1.19-1.39 (m, 2H) 1.53-1.62 (m, 1H) 1.78-1.86 (m, 1H) 2.55 (s, 3H) 2.55-2.62 (m, 1H) 2.69-2.78 (m, 1H) 3.42-3.51 (m, 2H) 3.55-3.63 (m, 1H) 4.37-5.01 (m, 1H) 7.36 (d, J=8.56 Hz, 2H) 7.42 (d, J=8.07

## 176

Hz, 1H) 7.83-7.89 (m, 2H) 7.93-8.00 (m, 1H) 8.07 (d, J=2.20 Hz, 1H) 8.71 (d, J=1.22 Hz, 1H) 8.75 (d, J=2.20 Hz, 1H) 10.29 (s, 1H).

## Example 127

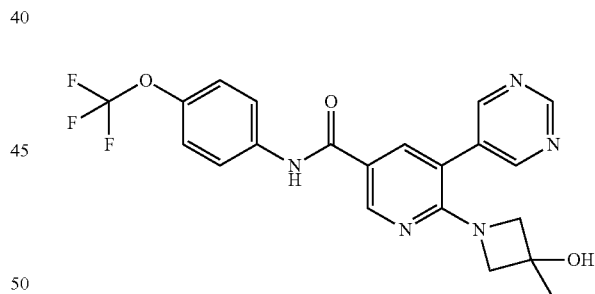
2-(3-Hydroxyazetidin-1-yl)-6'-methyl-N-(4-(trifluoromethoxy)phenyl)-[3,3'-bipyridine]-5-carboxamide



The title compound was prepared in an analogous fashion to that described in Example 57 using 5-bromo-6-chloro-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 12.2) and (6-methylpyridin-3-yl)boronic acid to afford an off-white solid. HPLC (Condition 4)  $t_R$ =4.1 min, UPLC-MS (Condition 3)  $t_R$ =0.92 min,  $m/z$ =445.2 [M+H]<sup>+</sup>; <sup>1</sup>H-NMR (400 MHz, DMSO-*d*<sub>6</sub>) δ ppm 2.52 (s, 3H) 3.45 (dd, J=9.38, 4.30 Hz, 2H) 3.85 (dd, J=9.38, 6.65 Hz, 2H) 4.34 (m, J=4.70 Hz, 1H) 5.51 (d, J=5.08 Hz, 1H) 7.34 (t, J=8.02 Hz, 3H) 7.72 (dd, J=7.82, 2.35 Hz, 1H) 7.79-7.88 (m, 2H) 7.94-8.01 (m, 1H) 8.49 (d, J=2.35 Hz, 1H) 8.69-8.77 (m, 1H) 10.19 (s, 1H).

## Example 128

6-(3-Hydroxy-3-methylazetidin-1-yl)-5-(pyrimidin-5-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide

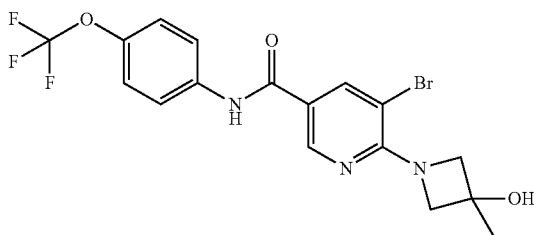


5-Bromo-6-(3-hydroxy-3-methylazetidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 128.1, 89 mg, 0.2 mmol) and pyrimidin-5-ylboronic acid (50 mg, 0.4 mmol) were dissolved in DME (0.8 mL). A solution of 2 M Na<sub>2</sub>CO<sub>3</sub> (0.300 mL, 0.6 mmol) and EtOH (120 μL) were added, the mixture was flushed with argon, Pd(PPh<sub>3</sub>)<sub>2</sub>Cl<sub>2</sub> (17 mg, 0.02 mmol) was added and the RM was heated at 95° C. for 3 h in a pressure safe vial. After cooling at RT, the RM was treated with EtOAc and washed with brine. The organic phase was dried over Na<sub>2</sub>SO<sub>4</sub> and evaporated to dryness under reduced pressure. The crude product was purified by flash chromatography (RediSep® Silica gel column, first EtOAc/MeOH from 0 to 10% MeOH; then second flash DCM/MeOH, from 2% to 5% MeOH) and treated with Si-Thiol (80 mg) in MeOH to

## 177

afford the title compound as a white crystalline solid. HPLC (Condition 4)  $t_R$ =4.74 min, UPLC-MS (Condition 7)  $m/z$ =446.3  $[M+H]^+$ ;  $^1H$ -NMR (400 MHz, DMSO- $d_6$ )  $\delta$  ppm 1.29 (s, 4H) 3.50-3.64 (m, 3H) 5.49 (s, 1H) 7.34 (d,  $J$ =8.60 Hz, 2H) 7.83 (d,  $J$ =8.99 Hz, 2H) 8.09 (d,  $J$ =1.56 Hz, 1H) 8.78 (d,  $J$ =1.95 Hz, 1H) 8.90 (s, 2H) 9.20 (s, 1H) 10.20 (s, 1H).

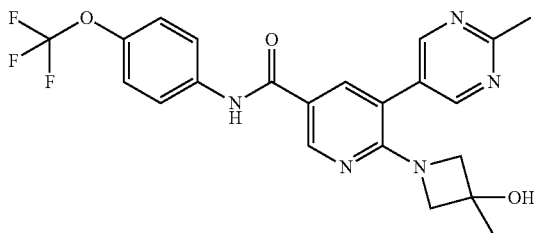
Stage 128.1 5-Bromo-6-(3-hydroxy-3-methylazetidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide



5-Bromo-6-chloro-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 12.2, 1.38 g, 3.5 mmol) and 3-methylazetidin-3-ol (HCl salt, 519 mg, 4.2 mmol) were dissolved in iPrOH (3.5 mL). DIPEA (1.4 mL, 8 mmol) was added and the RM mixture was heated at 140° C. for 4 h in a pressure safe vial. After cooling at RT, the RM was dissolved in EtOAc, washed with 0.5 M. HCl and brine. The organic phase was dried over  $Na_2SO_4$  and the mixture was evaporated to dryness under reduced pressure. The crude product was purified by flash chromatography (RediSep® Silica gel column, n-hexane/EtOAc, from 50 to 100% EtOAc) to afford the title compound as a white crystalline solid. HPLC (Condition 4)  $t_R$ =5.59 min, UPLC-MS (Condition 3)  $t_R$ =0.92 min,  $m/z$ =448.1  $[M+H]^+$ .

## Example 129

6-(3-Hydroxy-3-methylazetidin-1-yl)-5-(2-methylpyrimidin-5-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide



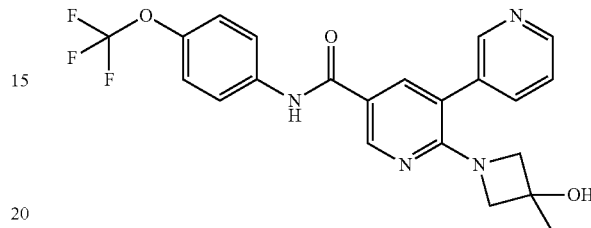
The title compound was prepared in an analogous fashion to that described in Example 128 using 5-bromo-6-(3-hydroxy-3-methylazetidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 128.1) and 2-methyl-5-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)pyrimidine to afford an off-white solid. HPLC (Condition 4)  $t_R$ =4.75 min, UPLC-MS (Condition 3)  $t_R$ =0.95 min,  $m/z$ =460.2  $[M+H]^+$ ;  $^1H$ -NMR (400 MHz, DMSO- $d_6$ )  $\delta$  ppm 1.29 (s, 3H) 2.68 (s, 3H) 3.58 (s,

## 178

4H) 5.47 (s, 1H) 7.26-7.40 (m, 2H) 7.77-7.92 (m, 2H) 8.04 (d,  $J$ =2.35 Hz, 1H) 8.67-8.82 (m, 3H) 10.19 (s, 1H).

## Example 130

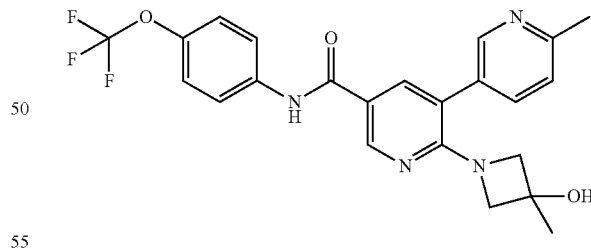
2-(3-Hydroxy-3-methylazetidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)-[3,3'-bipyridine]-5-carboxamide



The title compound was prepared in an analogous fashion to that described in Example 128 using 5-bromo-6-(3-hydroxy-3-methylazetidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 128.1) and pyridin-3-ylboronic acid. HPLC (Condition 4)  $t_R$ =4.45 min, UPLC-MS (Condition 3)  $t_R$ =0.95 min,  $m/z$ =445.3  $[M+H]^+$ ;  $^1H$ -NMR (400 MHz, DMSO- $d_6$ )  $\delta$  ppm 1.27 (s, 3H) 3.46-3.61 (m, 4H) 5.43 (s, 1H) 7.33 (d,  $J$ =8.99 Hz, 2H) 7.44-7.54 (m, 1H) 7.74-7.90 (m, 3H) 8.02 (d,  $J$ =1.95 Hz, 1H) 8.58 (dd,  $J$ =4.69, 1.56 Hz, 1H) 8.64 (d,  $J$ =2.35 Hz, 1H) 8.75 (d,  $J$ =2.35 Hz, 1H) 10.19 (s, 1H).

## Example 131

2-(3-Hydroxy-3-methylazetidin-1-yl)-6'-methyl-N-(4-(trifluoromethoxy)phenyl)-[3,3'-bipyridine]-5-carboxamide



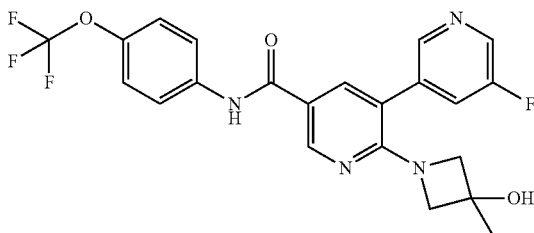
The title compound was prepared in an analogous fashion to that described in Example 128 using 5-bromo-6-(3-hydroxy-3-methylazetidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 128.1) and (6-methylpyridin-3-yl)boronic acid. HPLC (Condition 4)  $t_R$ =4.22 min, UPLC-MS (Condition 3)  $t_R$ =0.95 min,  $m/z$ =459.3  $[M+H]^+$ ;  $^1H$ -NMR (400 MHz, DMSO- $d_6$ )  $\delta$  ppm 1.27 (s, 3H) 2.52 (s, 3H) 3.45-3.61 (m, 4H) 5.41 (s, 1H) 7.34 (dd,  $J$ =8.21, 5.47 Hz, 3H) 7.72

## 179

(dd, J=8.21, 2.35 Hz, 1H) 7.80-7.88 (m, 2H) 7.97 (d, J=2.35 Hz, 1H) 8.49 (d, J=1.96 Hz, 1H) 8.73 (d, J=2.35 Hz, 1H) 10.18 (s, 1H).

## Example 132

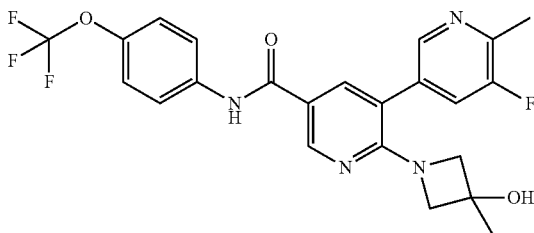
5'-Fluoro-2-(3-hydroxy-3-methylazetidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)-[3,3'-bipyridine]-5-carboxamide



The title compound was prepared in an analogous fashion to that described in Example 128 using 5-bromo-6-(3-hydroxy-3-methylazetidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 128.1) and (5-fluoropyridin-3-yl)boronic acid. HPLC (Condition 4)  $t_R$ =5.15 min, UPLC-MS (Condition 3)  $t_R$ =1.04 min,  $m/z$ =463.1  $[M+H]^+$ ;  $^1H$ -NMR (400 MHz, DMSO- $d_6$ )  $\delta$  ppm 1.29 (s, 3H) 3.57 (m, J=2.70 Hz, 4H) 5.48 (s, 1H) 7.34 (d, J=8.99 Hz, 2H) 7.84 (d, J=8.99 Hz, 3H) 8.01-8.10 (m, 1H) 8.53 (s, 1H) 8.61 (d, J=2.74 Hz, 1H) 8.72-8.84 (m, 1H) 10.20 (s, 1H).

## Example 133

5'-Fluoro-2-(3-hydroxy-3-methylazetidin-1-yl)-6'-methyl-N-(4-(trifluoromethoxy)phenyl)-[3,3'-bipyridine]-5-carboxamide



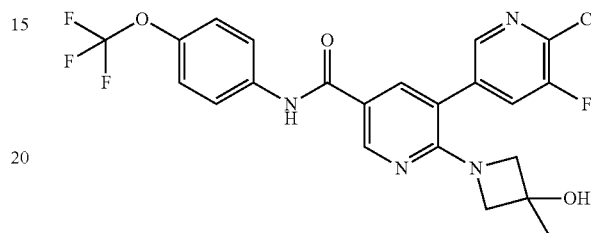
The title compound was prepared in an analogous fashion to that described in Example 52 using 6'-chloro-5'-fluoro-2-(3-hydroxy-3-methylazetidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)-[3,3'-bipyridine]-5-carboxamide (Example 134) and trimethyl-boroxine. HPLC (Condition 4)  $t_R$ =5.26 min, UPLC-MS (Condition 3)  $t_R$ =1.09 min,  $m/z$ =477.3  $[M+H]^+$ ;  $^1H$ -NMR (400 MHz, DMSO- $d_6$ )  $\delta$  ppm 1.29 (s, 3H) 2.42-2.55 (m, 3H) 3.50-3.65 (m, 4H) 5.46 (d, J=0.78 Hz, 1H) 7.34

## 180

(d, J=8.99 Hz, 2H) 7.74 (d, J=10.56 Hz, 1H) 7.83 (d, J=8.60 Hz, 2H) 7.97-8.05 (m, 1H) 8.37 (s, 1H) 8.71-8.78 (m, 1H) 10.19 (s, 1H).

## Example 134

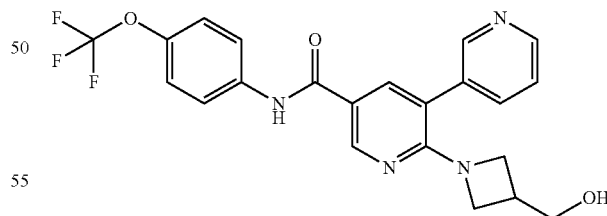
6'-Chloro-5'-fluoro-2-(3-hydroxy-3-methylazetidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)-[3,3'-bipyridine]-5-carboxamide



The title compound was prepared in an analogous fashion to that described in Example 53 using 5-bromo-6-(3-hydroxy-3-methylazetidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 128.1) and 2-chloro-3-fluoro-5-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)pyridine. HPLC (Condition 4)  $t_R$ =5.74 min, UPLC-MS (Condition 3)  $t_R$ =1.16 min,  $m/z$ =497.2  $[M+H]^+$ ;  $^1H$ -NMR (400 MHz, DMSO- $d_6$ )  $\delta$  ppm 1.30 (s, 3H) 3.60 (s, 4H) 5.48 (s, 1H) 7.34 (d, J=8.99 Hz, 2H) 7.83 (d, J=8.99 Hz, 2H) 8.00-8.15 (m, 2H) 8.38 (d, J=1.95 Hz, 1H) 8.77 (d, J=2.35 Hz, 1H) 10.21 (s, 1H).

## Example 135

6-(3-(Hydroxymethyl)azetidin-1-yl)-5-(pyrimidin-5-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide

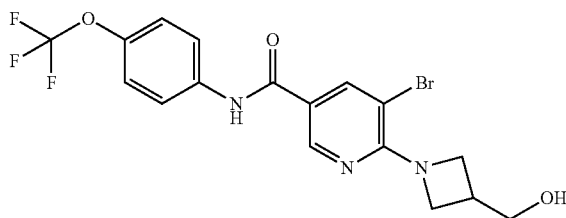


The title compound was prepared in an analogous fashion to that described in Example 128 using 5-bromo-6-(3-(hydroxymethyl)azetidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 135.1) and pyrimidin-5-ylboronic acid. HPLC (Condition 4)  $t_R$ =4.6 min, UPLC-MS (Condition 3)  $t_R$ =0.90 min,  $m/z$ =446.3  $[M+H]^+$ ;  $^1H$ -NMR (400 MHz, DMSO- $d_6$ )  $\delta$  ppm 2.53-2.68 (m, 1H) 3.38-3.53 (m, 4H) 3.63-3.77 (m, 2H) 4.68 (t, J=1.00 Hz, 1H) 7.33 (d, J=8.99 Hz, 2H)

## 181

7.83 (d, J=8.99 Hz, 2H) 8.05 (d, J=1.96 Hz, 1H) 8.77 (d, J=1.00 Hz, 1H) 8.89 (s, 2H) 9.15-9.31 (m, 1H) 10.18 (s, 1H).

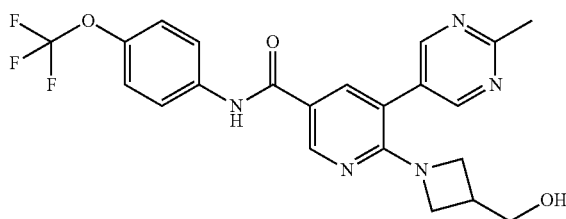
Stage 135.1 5-Bromo-6-(3-(hydroxymethyl)azetidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide



The title compound was prepared in an analogous fashion to that described in Stage 128.1 using 5-bromo-6-chloro-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 12.2) and azetidin-3-yl-methanol. HPLC (Condition 4)  $t_R$ =5.33 min, UPLC-MS (Condition 3)  $t_R$ =1.06 min,  $m/z$ =446.2.

## Example 136

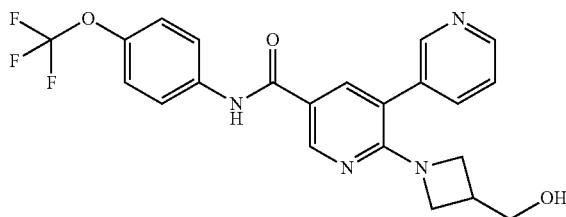
6-(3-(Hydroxymethyl)azetidin-1-yl)-5-(2-methylpyrimidin-5-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide



The title compound was prepared in an analogous fashion to that described in Example 128 using 5-bromo-6-(3-(hydroxymethyl)azetidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 135.1) and 2-methyl-5-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)pyrimidine. HPLC (Condition 4)  $t_R$ =4.61 min, UPLC-MS (Condition 3)  $t_R$ =0.95 min,  $m/z$ =460.3 [M+H]<sup>+</sup>; <sup>1</sup>H-NMR (400 MHz, DMSO-d<sub>6</sub>)  $\delta$  ppm 2.55-2.63 (m, 1H) 2.67 (s, 3H) 3.39-3.52 (m, 4H) 3.73 (t, J=8.60 Hz, 2H) 4.69 (t, J=5.28 Hz, 1H) 7.34 (d, J=8.99 Hz, 2H) 7.79-7.88 (m, 2H) 8.01 (d, J=2.35 Hz, 1H) 8.70-8.82 (m, 3H) 10.18 (s, 1H).

## Example 137

2-(3-(Hydroxymethyl)azetidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)-[3,3'-bipyridine]-5-carboxamide

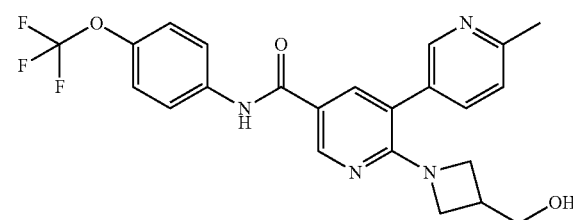


## 182

The title compound was prepared in an analogous fashion to that described in Example 128 using 5-bromo-6-(3-(hydroxymethyl)azetidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 135.1) and pyridin-3-ylboronic acid. HPLC (Condition 4)  $t_R$ =4.38 min, UPLC-MS (Condition 3)  $t_R$ =0.92 min,  $m/z$ =445.2 [M+H]<sup>+</sup>; <sup>1</sup>H-NMR (400 MHz, DMSO-d<sub>6</sub>)  $\delta$  ppm 2.53-2.68 (m, 1H) 3.37-3.49 (m, 4H) 3.68 (t, J=8.41 Hz, 2H) 4.66 (t, J=5.28 Hz, 1H) 7.33 (d, J=8.99 Hz, 2H) 7.49 (dd, J=7.82, 4.69 Hz, 1H) 7.84 (d, J=8.99 Hz, 3H) 7.99 (d, J=2.35 Hz, 1H) 8.54-8.60 (m, 1H) 8.64 (d, J=1.96 Hz, 1H) 8.72-8.78 (m, 1H) 10.18 (s, 1H).

## Example 138

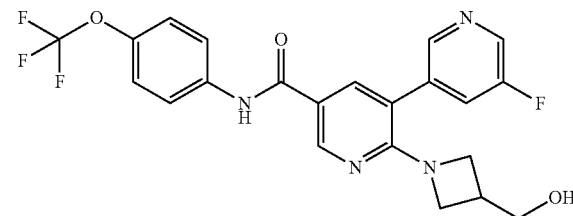
2-(3-(Hydroxymethyl)azetidin-1-yl)-6'-methyl-N-(4-(trifluoromethoxy)phenyl)-[3,3'-bipyridine]-5-carboxamide



The title compound was prepared in an analogous fashion to that described in Example 128 using 5-bromo-6-(3-(hydroxymethyl)azetidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 135.1) and (6-methylpyridin-3-yl)boronic acid. HPLC (Condition 4)  $t_R$ =4.18 min, UPLC-MS (Condition 3)  $t_R$ =0.93 min,  $m/z$ =459.2 [M+H]<sup>+</sup>; <sup>1</sup>H-NMR (400 MHz, DMSO-d<sub>6</sub>)  $\delta$  ppm 2.48 (s, 3H) 2.58 (t, J=5.87 Hz, 1H) 3.39-3.47 (m, 4H) 3.69 (t, J=8.60 Hz, 2H) 4.66 (t, J=5.28 Hz, 1H) 7.33 (m, J=8.40, 2.50 Hz, 3H) 7.71 (dd, J=7.82, 2.35 Hz, 1H) 7.81-7.86 (m, 2H) 7.95 (d, J=2.35 Hz, 1H) 8.49 (d, J=2.35 Hz, 1H) 8.73 (d, J=1.95 Hz, 1H) 10.17 (s, 1H).

## Example 139

5'-Fluoro-2-(3-(hydroxymethyl)azetidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)-[3,3'-bipyridine]-5-carboxamide

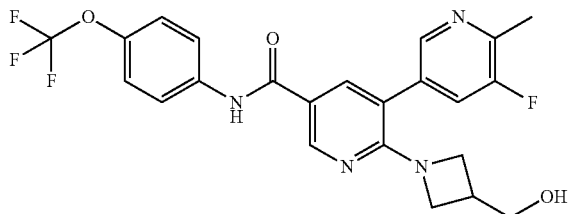


The title compound was prepared in an analogous fashion to that described in Example 128 using 5-bromo-6-(3-(hydroxymethyl)azetidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 135.1) and 3-fluoro-5-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)pyridine. HPLC (Condition 4)  $t_R$ =5.02 min, UPLC-MS (Condition 3)  $t_R$ =1.01 min,  $m/z$ =463.2 [M+H]<sup>+</sup>; <sup>1</sup>H-NMR (400 MHz, DMSO-d<sub>6</sub>)  $\delta$  ppm 2.56-2.68 (m, 1H) 3.37-3.52 (m, 4H) 3.71 (t, J=8.60 Hz, 2H) 4.68 (t, J=1.00 Hz, 1H) 7.34 (d, J=8.60 Hz, 2H) 7.77-7.90 (m, 3H) 8.04 (d, J=2.35 Hz, 1H) 8.49-8.55 (m, 1H) 8.60 (d, J=2.74 Hz, 1H) 8.76 (d, J=2.35 Hz, 1H) 10.18 (s, 1H).

## 183

## Example 140

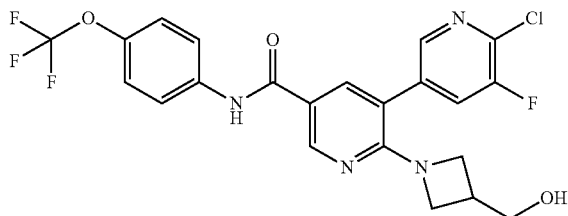
5'-Fluoro-2-(3-(hydroxymethyl)azetidin-1-yl)-6'-methyl-N-(4-(trifluoromethoxy)phenyl)-[3,3'-bipyridine]-5-carboxamide



The title compound was prepared in an analogous fashion to that described in Example 52 using 6'-chloro-5'-fluoro-2-(3-(hydroxymethyl)azetidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)-[3,3'-bipyridine]-5-carboxamide (Example 141). HPLC (Condition 4)  $t_R$ =5.15 min, UPLC-MS (Condition 3)  $t_R$ =1.05 min,  $m/z$ =477.2  $[M+H]^+$ ;  $^1H$ -NMR (400 MHz, DMSO- $d_6$ )  $\delta$  ppm 2.45-2.53 (m, 3H) 2.55-2.70 (m, 1H) 3.36-3.52 (m, 4H) 3.72 (t,  $J$ =8.41 Hz, 2H) 4.68 (t,  $J$ =5.08 Hz, 1H) 7.33 (d,  $J$ =8.99 Hz, 2H) 7.74 (d,  $J$ =10.56 Hz, 1H) 7.79-7.89 (m, 2H) 7.97-8.02 (m, 1H) 8.37 (d,  $J$ =1.56 Hz, 1H) 8.74 (m,  $J$ =2.00, 1.20 Hz, 1H) 10.18 (s, 1H).

## Example 141

6'-Chloro-5'-fluoro-2-(3-(hydroxymethyl)azetidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)-[3,3'-bipyridine]-5-carboxamide

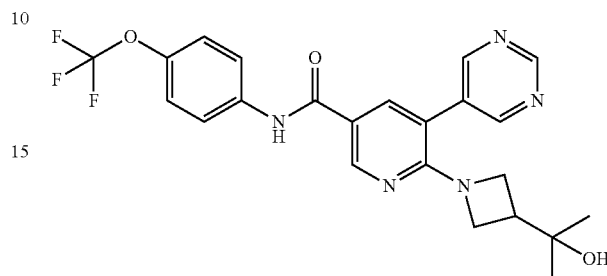


The title compound was prepared in an analogous fashion to that described in Example 53 using 5-bromo-6-(3-(hydroxymethyl)azetidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 135.1) and 2-chloro-3-fluoro-5-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)pyridine. HPLC (Condition 4)  $t_R$ =5.57 min, UPLC-MS (Condition 3)  $t_R$ =1.13 min,  $m/z$ =497.1  $[M+H]^+$ ;  $^1H$ -NMR (400 MHz, DMSO- $d_6$ )  $\delta$  ppm 2.55-2.70 (m, 1H) 3.39-3.53 (m, 4H) 3.73 (t,  $J$ =1.00 Hz, 2H) 4.69 (t,  $J$ =1.00 Hz, 1H) 7.34 (d,  $J$ =8.21 Hz, 2H) 7.83 (m,

## 184

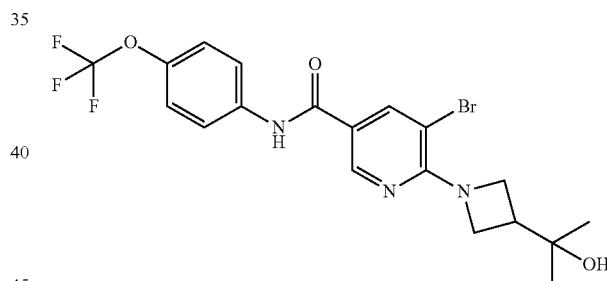
## Example 142

6-(3-(2-Hydroxypropan-2-yl)azetidin-1-yl)-5-(pyrimidin-5-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide



The title compound was prepared in an analogous fashion to that described in Example 128 using 5-bromo-6-(3-(2-hydroxypropan-2-yl)azetidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 142.1) and pyrimidin-5-ylboronic acid to afford an off-white powder. HPLC (Condition 4)  $t_R$ =4.88 min, UPLC-MS (Condition 7)  $m/z$ =474.2  $[M+H]^+$ ;  $^1H$ -NMR (400 MHz, DMSO- $d_6$ )  $\delta$  ppm 0.94 (s, 6H) 2.50-2.58 (m, 1H) 3.63 (d,  $J$ =7.43 Hz, 4H) 4.39 (s, 1H) 7.34 (d,  $J$ =8.99 Hz, 2H) 7.49-7.68 (m, 1H) 7.79-7.91 (m, 2H) 8.06 (dd,  $J$ =2.15, 0.98 Hz, 1H) 8.73-8.81 (m, 1H) 8.85-8.96 (m, 1H) 9.20 (d,  $J$ =0.78 Hz, 1H) 10.19 (s, 1H).

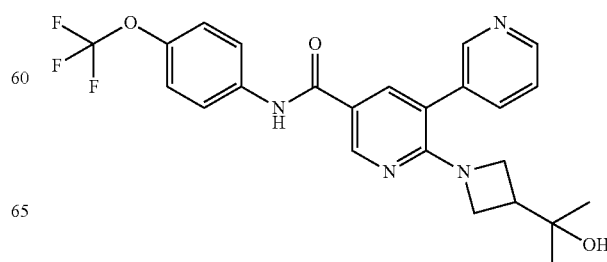
Stage 142.1 5-Bromo-6-(3-(2-hydroxypropan-2-yl)azetidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide



The title compound was prepared in an analogous fashion to that described in Stage 128.1 using 5-bromo-6-chloro-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 12.2) and 2-azetidin-3-yl-propan-2-ol (WO2010138589) to afford an off-white crystalline product. HPLC (Condition 4)  $t_R$ =5.84 min, UPLC-MS (Condition 7)  $m/z$ =474.1  $[M+H]^+$ .

## Example 143

2-(3-(2-Hydroxypropan-2-yl)azetidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)-[3,3'-bipyridine]-5-carboxamide

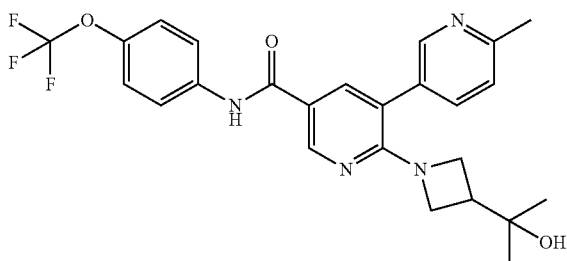


## 185

The title compound was prepared in an analogous fashion to that described in Example 128 using 5-bromo-6-(3-(2-hydroxypropan-2-yl)azetidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 142.1) and pyridin-3-ylboronic acid to afford an off-white powder. HPLC (Condition 4)  $t_R$ =4.61 min, UPLC-MS (Condition 7)  $m/z$ =473.1  $[M+H]^+$ ;  $^1H$ -NMR (400 MHz, DMSO- $d_6$ )  $\delta$  ppm 0.93 (s, 6H) 3.24-3.34 (m, 1H) 3.59 (m,  $J$ =8.60 Hz, 4H) 4.36 (s, 1H) 7.33 (d,  $J$ =8.60 Hz, 2H) 7.49 (dd,  $J$ =7.82, 4.69 Hz, 1H) 7.84 (d,  $J$ =8.99 Hz, 3H) 8.00 (d,  $J$ =1.95 Hz, 1H) 8.53-8.62 (m, 1H) 8.65 (d,  $J$ =1.95 Hz, 1H) 8.74 (d,  $J$ =1.96 Hz, 1H) 10.18 (s, 1H).

## Example 144

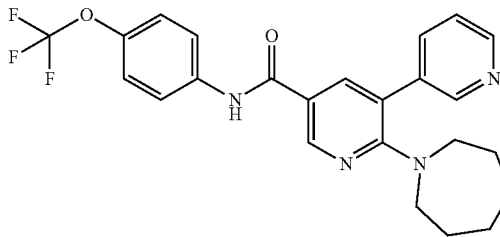
2-(3-(2-Hydroxypropan-2-yl)azetidin-1-yl)-6'-methyl-N-(4-(trifluoromethoxy)phenyl)-[3,3'-bipyridine]-5-carboxamide



The title compound was prepared in an analogous fashion to that described in Example 128 using 5-bromo-6-(3-(2-hydroxypropan-2-yl)azetidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 142.1) and (6-methylpyridin-3-yl)boronic acid to afford an off-white foam. HPLC (Condition 4)  $t_R$ =4.37 min, UPLC-MS (Condition 7)  $m/z$ =487.2  $[M+H]^+$ ;  $^1H$ -NMR (400 MHz, DMSO- $d_6$ )  $\delta$  ppm 0.93 (s, 6H) 2.49 (s, 3H) 3.31 (br s, 1H) 3.54-3.66 (m, 4H) 4.36 (d,  $J$ =0.78 Hz, 1H) 7.22-7.43 (m, 3H) 7.73 (dd,  $J$ =7.82, 2.35 Hz, 1H) 7.79-7.88 (m, 2H) 7.95 (d,  $J$ =2.35 Hz, 1H) 8.51 (d,  $J$ =1.96 Hz, 1H) 8.72 (d,  $J$ =2.35 Hz, 1H) 10.17 (s, 1H).

## Example 145

2-(1,4-Diazepan-1-yl)-N-(4-(trifluoromethoxy)phenyl)-[3,3'-bipyridine]-5-carboxamide

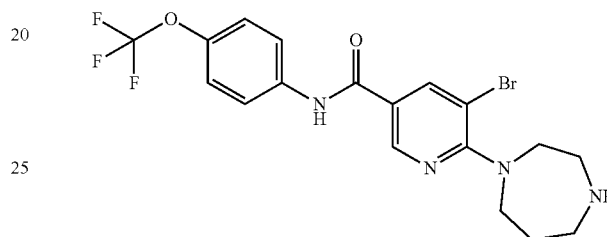


A mixture of 5-bromo-6-(1,4-diazepan-1-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 145.1, 51 mg, 0.111 mmol), pyridin-3-ylboronic acid (13.6 mg, 0.111 mmol), and  $Na_2CO_3$  (35 mg, 0.333 mmol) in a mixture of

## 186

DME (2.4 mL), EtOH (0.32 mL) and water (0.48 mL) was flushed with argon.  $Pd(PPh_3)_2Cl_2$  (4 mg, 0.005 mmol) was added and the mixture was subjected to MW irradiation at 125° C. for 20 min. The vial was cooled to RT and the RM was evaporated to dryness under reduced pressure to give a residue that was triturated with THF and filtered. The filtrate was evaporated to dryness under reduced pressure and the crude product was purified by preparative LC-MS. TFA was removed using a SPE PL- $HCO_3$  (StratoSpheres™) cartridge to afford the title compound. UPLC-MS (Condition 8)  $t_R$ =1.7 min,  $m/z$ =458.1  $[M+H]^+$ ,  $m/z$ =456.2  $[M-H]^-$ .

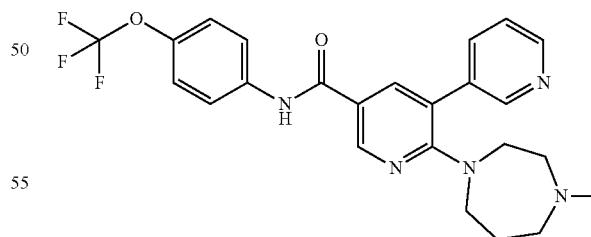
Stage 145.1 5-Bromo-6-(1,4-diazepan-1-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide



A mixture of 5-bromo-6-chloro-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 12.2, 198 mg, 0.50 mmol), 1,4-diazepane (60.2 mg, 0.60 mmol), iPrOH (2 mL) and DIPEA (0.171 mL, 0.129 g, 2.0 mmol) were subjected to MW irradiation 140° C. for 80 min. The vial was cooled to RT and the RM was poured into water (40 mL) to give a suspension. The supernatant was decanted off and the residue was dried under vacuum to afford the title compound. UPLC-MS (Condition 8)  $t_R$ =1.15 min,  $m/z$ =459.1/461.1  $[M+H]^+$ ,  $m/z$ =457.1/459.1  $[M-H]^-$ .

## Example 146

2-(4-Methyl-1,4-diazepan-1-yl)-N-(4-(trifluoromethoxy)phenyl)-[3,3'-bipyridine]-5-carboxamide

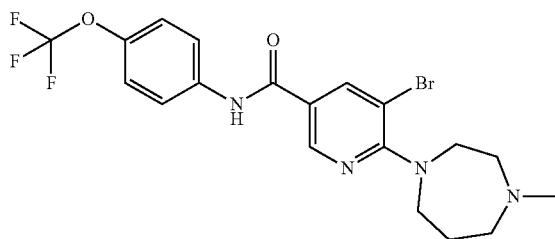


A mixture of 5-bromo-6-(4-methyl-1,4-diazepan-1-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 146.1, 74 mg, 0.150 mmol), pyridin-3-ylboronic acid (18.5 mg, 0.150 mmol) and  $Na_2CO_3$  (48 mg, 0.450 mmol) in a mixture of DME (3.2 mL), EtOH (0.43 mL), and water (0.64 mL) was flushed with argon.  $Pd(PPh_3)_2Cl_2$  (5.3 mg, 0.0075 mmol) was added and the mixture was subjected to MW irradiation at 125° C. for 30 min. The RM was evaporated to dryness under

## 187

reduced pressure and the residue was triturated with THF and filtered. The filtrate was evaporated to dryness under reduced pressure and the crude product was purified by preparative LC-MS. TFA was removed using a SPE PL-HCO<sub>3</sub> (StratoSpheres™ VariPure IPE) cartridge to afford the title compound. UPLC-MS (Condition 8)  $t_R$ =1.71 min,  $m/z$ =472.1 [M+H]<sup>+</sup>,  $m/z$ =470.2 [M-H]<sup>-</sup>.

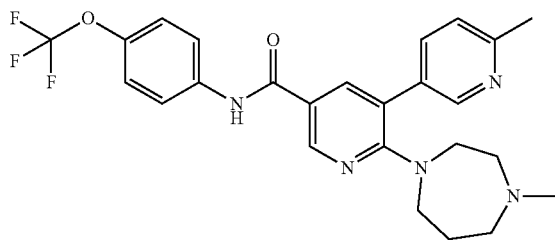
Stage 146.1 5-Bromo-6-(4-methyl-1,4-diazepan-1-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide



A mixture of 5-bromo-6-chloro-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 12.2, 198 mg, 0.50 mmol), 1-methyl-1,4-diazepane (68.6 mg, 0.60 mmol), iPrOH (2 mL) and DIPEA (0.171 mL, 0.129 g, 2.0 mmol) were subjected to MW irradiation at 140° C. for 95 min. The RM was concentrated under reduced pressure to afford the title compound in an

## Example 147

6'-Methyl-2-(4-methyl-1,4-diazepan-1-yl)-N-(4-(trifluoromethoxy)phenyl)-[3,3'-bipyridine]-5-carboxamide



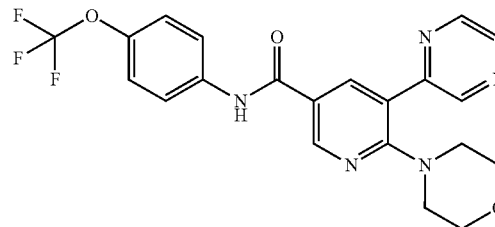
A mixture of 5-bromo-6-(4-methyl-1,4-diazepan-1-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 146.1, 74 mg, 0.150 mmol), (6-methylpyridin-3-yl)boronic acid (20.6 mg, 0.150 mmol) and Na<sub>2</sub>CO<sub>3</sub> (48 mg, 0.450 mmol) in a mixture of DME (3.2 mL), EtOH (0.43 mL) and water (0.64 mL) was flushed with argon. Pd(PPh<sub>3</sub>)<sub>2</sub>Cl<sub>2</sub> (5.3 mg, 0.0075 mmol) was added and the mixture was subjected to MW irradiation at 125° C. for 30 min. The RM was evaporated to dryness under reduced pressure and the residue was triturated with THF and filtered. The filtrate was evaporated to dryness under reduced pressure and the crude product was purified by preparative HPLC. TFA was removed using a SPE PL-HCO<sub>3</sub> (StratoSpheres™ VariPure IPE) cartridge to afford the title

## 188

compound. UPLC-MS (Condition 8)  $t_R$ =1.55 min,  $m/z$ =243.6 [M+2H]<sup>+</sup>,  $m/z$ =484.2 [M-H]<sup>-</sup>.

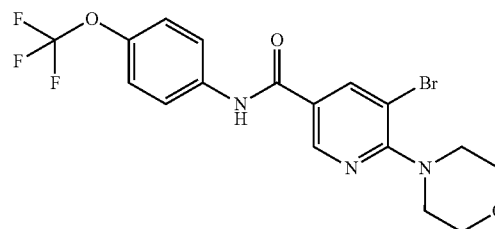
## Example 148

6-Morpholino-5-(pyrimidin-5-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide



5-Bromo-6-morpholino-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 148.1, 60 mg, 0.134 mmol), pyrimidin-5-ylboronic acid (50 mg, 0.403 mmol), Pd(Ph<sub>3</sub>P)<sub>4</sub> (12.43 mg, 10.76 μmol) and finely ground K<sub>3</sub>PO<sub>4</sub> (143 mg, 0.672 mmol) were added to a MW vial and treated with toluene (672 μL). The vial was sealed, evacuated/purged with argon then the RM was stirred 110° C. for 16 h, diluted with DME (2 mL), treated with Si-Thiol (Silicycle, 1.44 mmol/g, 56.0 mg, 0.081 mmol), centrifuged, the supernatant was filtered and the solvent was evaporated off under reduced pressure to give a residue which was purified by preparative SFC (Column Diol, from 15% to 20% in 6 min) to yield the title product as a white solid. UPLC-MS (Condition 3)  $t_R$ =1.00 min,  $m/z$ =446.3 [M+H]<sup>+</sup>,  $m/z$ =444.1 [M-H]<sup>-</sup>; <sup>1</sup>H-NMR (400 MHz, DMSO-d<sub>6</sub>) δ ppm 3.09-3.20 (m, 4H) 3.50-3.60 (m, 4H) 7.38 (d, J=8.28 Hz, 2H) 7.86 (d, J=9.16 Hz, 2H) 8.23 (d, J=2.38 Hz, 1H) 8.84 (d, J=2.38 Hz, 1H) 9.13 (s, 2H) 9.22 (s, 1H) 10.37 (s, 1H).

Stage 148.1 5-Bromo-6-morpholino-N-(4-(trifluoromethoxy)phenyl)nicotinamide



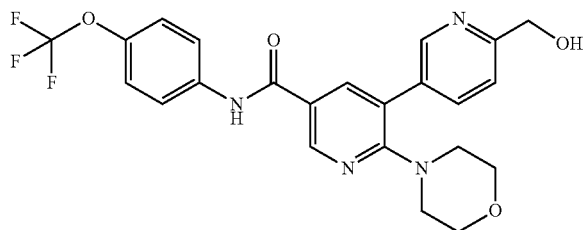
The title compound was prepared in an analogous fashion to that described in Stage 12.1 using 5-bromo-6-chloro-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 12.2) and morpholine to afford an off-white solid. UPLC-MS (Condition 3)  $t_R$ =1.20 min,  $m/z$ =445.9 [M+H]<sup>+</sup>,  $m/z$ =443.9 [M-H]<sup>-</sup>; <sup>1</sup>H-NMR (400 MHz, DMSO-d<sub>6</sub>) δ ppm 3.37-3.46 (m, 4H)

## 189

3.69-3.81 (m, 4H) 7.39 (d, J=8.78 Hz, 2H) 7.86 (d, J=9.16 Hz, 2H) 8.47 (d, J=2.13 Hz, 1H) 8.80 (d, J=2.13 Hz, 1H) 10.44 (s, 1H).

## Example 149

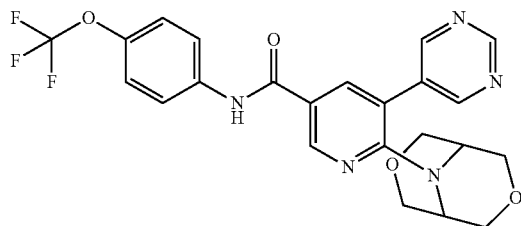
6'-(Hydroxymethyl)-2-morpholino-N-(4-(trifluoromethoxy)phenyl)-[3,3'-bipyridine]-5-carboxamide



5-Bromo-6-morpholino-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 148.1, 60 mg, 0.134 mmol), (6-(hydroxymethyl)pyridin-3-yl)boronic acid (41.1 mg, 0.269 mmol), Pd(PPh<sub>3</sub>)<sub>2</sub>Cl<sub>2</sub> (9.44 mg, 0.013 mmol) and Na<sub>2</sub>CO<sub>3</sub> (42.8 mg, 0.403 mmol) were added to a MW vial and treated with a mixture of DME (570 μL), water (163 μL) and EtOH (81 μL). The vial was sealed, evacuated/purged with argon and subjected to MW irradiation at 125° C. for 20 min and then at 130° C. for 20 min, diluted with DME (2 mL) and treated with Si-Thiol (Silicycle, 1.44 mmol/g, 46.7 mg, 0.067 mmol). The RM was centrifuged, the supernatant was filtered and the solvent was evaporated off under reduced pressure to give a residue which was purified by preparative SFC (Column 2-EP, from 15% to 20% in 6 min) to yield the title product as a white solid. UPLC-MS (Condition 3) t<sub>R</sub>=0.95 min, m/z=475.4 [M+H]<sup>+</sup>, m/z=473.2 [M-H]<sup>-</sup>; <sup>1</sup>H-NMR (400 MHz, DMSO-d<sub>6</sub>) δ ppm 3.07-3.22 (m, 4H) 3.48-3.62 (m, 4H) 4.63 (s, 2H) 5.54 (br. s, 1H) 7.38 (d, J=8.53 Hz, 2H) 7.60 (d, J=8.03 Hz, 1H) 7.82-7.92 (m, 2H) 8.11 (d, J=8.28 Hz, 1H) 8.13-8.16 (m, 1H) 8.75-8.79 (m, 1H) 8.79-8.86 (m, 1H) 10.38 (br. s, 1H).

## Example 150

6-(3,7-Dioxa-9-azabicyclo[3.3.1]nonan-9-yl)-5-(pyrimidin-5-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide

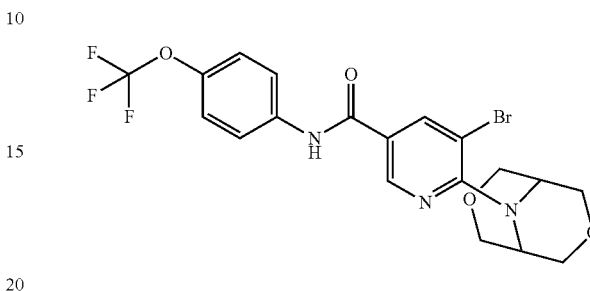


The title compound was prepared in an analogous fashion to that described in Example 133 using 6-(3,7-dioxa-9-azabicyclo[3.3.1]nonan-9-yl)-5-bromo-N-(4-(trifluoromethoxy)

## 190

phenyl)nicotinamide (Stage 150.1) and pyrimidin-5-ylboronic acid to afford a solid. HPLC (Condition 4) t<sub>R</sub>=5.08 min, UPLC-MS (Condition 3) t<sub>R</sub>=1.00 min, m/z=488.2 [M+H]<sup>+</sup>.

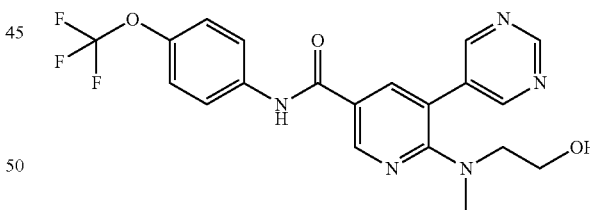
5 Stage 150.1 6-(3,7-Dioxa-9-azabicyclo[3.3.1]nonan-9-yl)-5-bromo-N-(4-(trifluoromethoxy)phenyl)nicotinamide



5-Bromo-6-chloro-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 12.2, 55.4 mg, 0.14 mmol) and 3,7-Dioxa-9-aza-bicyclo[3.3.1]nonane (Organic Chemistry (2006), 71(1), 413-415) (24.53 mg, 0.14 mmol) were dissolved in DMF (150 μL). KF (24.4 mg, 0.42 mmol) was added and the RM mixture was stirred at 140° C. for 18 h in a pressure safe vial. After cooling at RT, the RM was dissolved in EtOAc and washed with brine. The organic phase was dried over Na<sub>2</sub>SO<sub>4</sub> and evaporated to dryness under reduced pressure to give a residue that was purified by flash chromatography (RediSep® Silica gel column, n-hexane/EtOAc from 20% to 60% EtOAc) to afford the title compound as a white solid. HPLC (Condition 4) t<sub>R</sub>=5.84 min, UPLC-MS (Condition 3) t<sub>R</sub>=1.19 min, m/z=490.1 [M+H]<sup>+</sup>.

## Example 151

6-((2-Hydroxyethyl)(methyl)amino)-5-(pyrimidin-5-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide

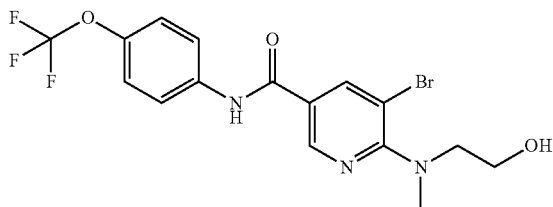


5-Bromo-6-((2-hydroxyethyl)(methyl)amino)-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 151.1, 59 mg, 0.136 mmol), pyrimidin-5-ylboronic acid (33.7 mg, 0.272 mmol), Pd(PPh<sub>3</sub>)<sub>2</sub>Cl<sub>2</sub> (9.54 mg, 0.014 mmol) and Na<sub>2</sub>CO<sub>3</sub> (57.6 mg, 0.544 mmol) were added to a MW vial and treated with a mixture of DME (576 μL), water (165 μL) and EtOH (82 μL). The vial was sealed, evacuated/purged with argon and subjected to MW irradiation at 125° C. for 20 min, diluted with DME (3 mL) and treated with Si-Thiol (Silicycle, 1.44 mmol/g, 56.6 mg, 0.082 mmol). The RM was centrifuged, the supernatant was filtered and the solvent was evaporated off under reduced pressure to give a residue which was purified by preparative SFC (Column DEAP, from 10% to 15% in 10

## 191

min) to yield the title product as a white solid. UPLC-MS (Condition 3)  $t_R=0.92$  min,  $m/z=434.3$   $[M+H]^+$ ,  $m/z=432.3$   $[M-H]^-$ ;  $^1H$ -NMR (400 MHz, DMSO- $d_6$ )  $\delta$  ppm 2.71 (s, 3H) 3.44-3.52 (m, 2H) 3.53-3.60 (m, 2H) 4.68 (t,  $J=5.14$  Hz, 1H) 7.36 (d,  $J=8.41$  Hz, 2H) 7.82-7.90 (m, 2H) 8.15 (d,  $J=2.38$  Hz, 1H) 8.77 (d,  $J=2.38$  Hz, 1H) 8.97 (s, 2H) 9.19 (s, 1H) 10.23 (s, 1H).

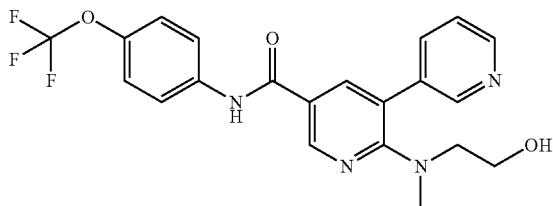
Stage 151.1 5-Bromo-6-((2-hydroxyethyl)(methyl)amino)-N-(4-(trifluoromethoxy)phenyl)nicotinamide



The title compound was prepared in an analogous fashion to that described in Stage 33.1 using 5-bromo-6-chloro-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 12.2) and 2-methylamino-ethanol to afford an off-white crystalline solid. HPLC (Condition 4)  $t_R=5.57$  min, UPLC-MS (Condition 3)  $t_R=1.11$  min,  $m/z=434.1$   $[M+H]^+$ .

## Example 152

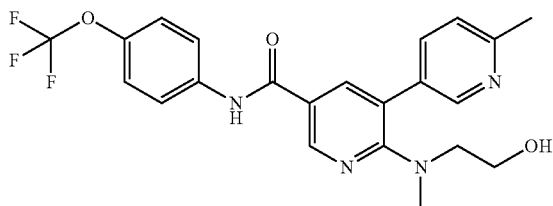
2-((2-Hydroxyethyl)(methyl)amino)-N-(4-(trifluoromethoxy)phenyl)-[3,3'-bipyridine]-5-carboxamide



A mixture of 5-bromo-6-((2-hydroxyethyl)(methyl)amino)-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 151.1, 60 mg), pyridin-3-ylboronic acid (25 mg), 2 M  $Na_2CO_3$  (0.2 mL, 0.4 mmol) and DME (4 mL) was flushed with argon,  $PdCl_2(dppf)(CH_2Cl_2)$  (10 mg, 0.012 mmol) was added and the mixture was subjected to MW irradiation at  $140^\circ C$ . for 30 min. The RM was filtered through a PL-Thiol MP SPE cartridge (StratoSpheres<sup>TM</sup>, 6 mL), the cartridge was washed with MeOH and the solvent was evaporated off under reduced pressure to give a residue which was purified by preparative LC-MS to afford the title compound. LC-MS (Condition 6)  $t_R=0.91$  min,  $m/z=432.9$   $[M+H]^+$ .

## Example 153

2-((2-Hydroxyethyl)(methyl)amino)-6'-methyl-N-(4-(trifluoromethoxy)phenyl)-[3,3'-bipyridine]-5-carboxamide

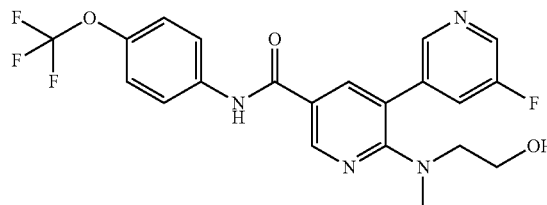


## 192

The title compound was prepared in an analogous fashion to that described in Example 152 using 5-bromo-6-((2-hydroxyethyl)(methyl)amino)-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 151.1) and (6-methylpyridin-3-yl)boronic acid. LC-MS (Condition 6)  $t_R=0.91$  min,  $m/z=447.0$   $[M+H]^+$ .

## Example 154

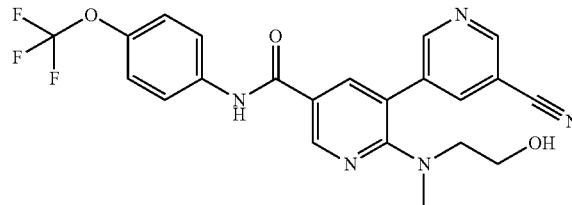
5'-Fluoro-2-((2-hydroxyethyl)(methyl)amino)-N-(4-(trifluoromethoxy)phenyl)-[3,3'-bipyridine]-5-carboxamide



The title compound was prepared in an analogous fashion to that described in Example 151 using 5-bromo-6-((2-hydroxyethyl)(methyl)amino)-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 151.1) and (5-fluoropyridin-3-yl)boronic acid to afford a white solid. UPLC-MS (Condition 3)  $t_R=1.04$  min,  $m/z=451.3$   $[M+H]^+$ ,  $m/z=449.2$   $[M-H]^-$ ;  $^1H$ -NMR (400 MHz, DMSO- $d_6$ )  $\delta$  ppm 2.71 (s, 3H) 3.44-3.51 (m, 2H) 3.56 (q,  $J=5.40$  Hz, 2H) 4.68 (t,  $J=5.14$  Hz, 1H) 7.36 (d,  $J=8.41$  Hz, 2H) 7.82-7.87 (m, 2H) 7.87-7.93 (m, 1H) 8.12 (d,  $J=2.38$  Hz, 1H) 8.58 (d,  $J=2.76$  Hz, 1H) 8.61 (t,  $J=1.69$  Hz, 1H) 8.75 (d,  $J=2.38$  Hz, 1H) 10.22 (s, 1H).

## Example 155

5'-Cyano-2-((2-hydroxyethyl)(methyl)amino)-N-(4-(trifluoromethoxy)phenyl)-[3,3'-bipyridine]-5-carboxamide

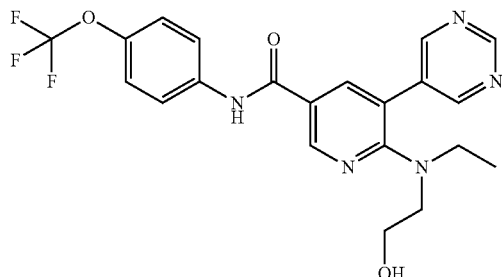


The title compound was prepared in an analogous fashion to that described in Example 151 using 5-bromo-6-((2-hydroxyethyl)(methyl)amino)-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 151.1) and 5-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)nicotinonitrile to afford a yellow wax. UPLC-MS (Condition 3)  $t_R=1.02$  min,  $m/z=458.3$   $[M+H]^+$ ,  $m/z=456.3$   $[M-H]^-$ ;  $^1H$ -NMR (400 MHz, DMSO- $d_6$ )  $\delta$  ppm 2.69 (s, 3H) 3.47 (t,  $J=5.38$  Hz, 2H) 3.56 (t,  $J=6.11$  Hz, 2H) 4.34-4.84 (m, 1H) 7.36 (d,  $J=8.31$  Hz, 2H) 7.79-7.90 (m, 2H) 8.14 (d,  $J=2.45$  Hz, 1H) 8.45 (t,  $J=2.08$  Hz, 1H) 8.77 (d,  $J=2.20$  Hz, 1H) 9.00 (dd,  $J=7.21, 2.08$  Hz, 2H) 10.21 (s, 1H).

## 193

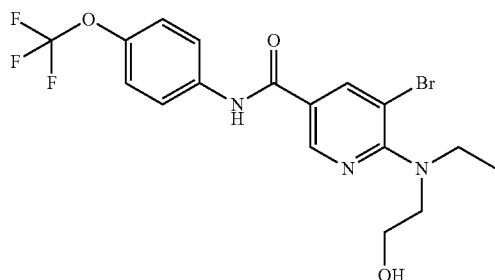
## Example 156

6-(Ethyl(2-hydroxyethyl)amino)-5-(pyrimidin-5-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide



The title compound was prepared in an analogous fashion to that described in Example 151 using 5-bromo-6-(ethyl(2-hydroxyethyl)amino)-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 156.1) and pyrimidin-5-ylboronic acid to afford a white solid. UPLC-MS (Condition 3)  $t_R=0.97$  min,  $m/z=448.3$   $[M+H]^+$ ,  $m/z=446.3$   $[M-H]^-$ ;  $^1H$ -NMR (400 MHz, DMSO- $d_6$ )  $\delta$  ppm 0.89 (t,  $J=6.96$  Hz, 3H) 3.11-3.16 (m, 2H) 3.34-3.41 (m, 2H) 3.49 (q,  $J=5.65$  Hz, 2H) 4.62 (t,  $J=5.27$  Hz, 1H) 7.36 (d,  $J=8.41$  Hz, 2H) 7.80-7.90 (m, 2H) 8.11 (d,  $J=2.38$  Hz, 1H) 8.78 (d,  $J=2.26$  Hz, 1H) 9.03 (s, 2H) 9.21 (s, 1H) 10.26 (s, 1H).

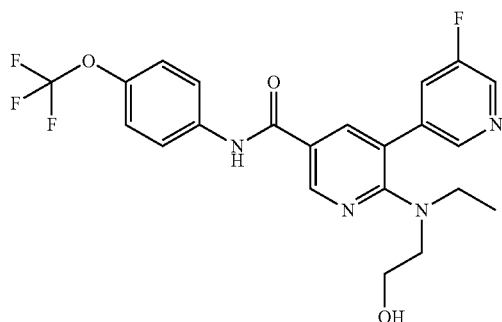
Stage 156.1 5-Bromo-6-(ethyl(2-hydroxyethyl)amino)-N-(4-(trifluoromethoxy)phenyl)nicotinamide



The title compound was prepared in an analogous fashion to that described in Stage 33.1 using 5-bromo-6-chloro-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 12.2) and 2-(ethylamino)ethanol to afford a white solid. (The RM was heated 18 h at 140° C.). HPLC (Condition 4)  $t_R=5.92$  min, UPLC-MS (Condition 3)  $t_R=1.19$  min,  $m/z=450.1$   $[M+H]^+$ .

## Example 157

2-(Ethyl(2-hydroxyethyl)amino)-5'-fluoro-N-(4-(trifluoromethoxy)phenyl)-[3,3'-bipyridine]-5-carboxamide

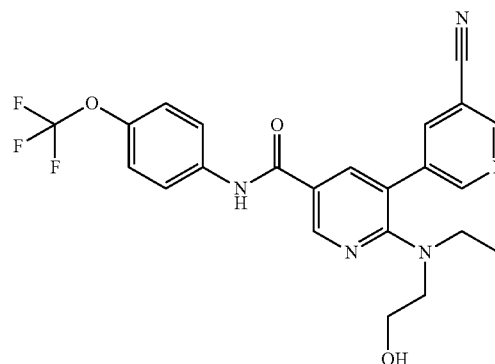


## 194

The title compound was prepared in an analogous fashion to that described in Example 151 using 5-bromo-6-(ethyl(2-hydroxyethyl)amino)-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 156.1) and (5-fluoropyridin-3-yl)boronic acid to afford a white solid. UPLC-MS (Condition 3)  $t_R=1.09$  min,  $m/z=465.3$   $[M+H]^+$ ,  $m/z=463.4$   $[M-H]^-$ ;  $^1H$ -NMR (400 MHz, DMSO- $d_6$ )  $\delta$  ppm 0.90 (t,  $J=7.03$  Hz, 3H) 3.16 (q,  $J=7.03$  Hz, 2H) 3.35-3.42 (m, 2H) 3.49 (br. s, 2H) 4.62 (br. s, 1H) 7.36 (d,  $J=8.41$  Hz, 2H) 7.80-7.89 (m, 2H) 7.98 (m,  $J=2.70$ , 1.82 Hz, 1H) 8.08 (d,  $J=2.38$  Hz, 1H) 8.60 (d,  $J=2.76$  Hz, 1H) 8.64 (t,  $J=1.63$  Hz, 1H) 8.76 (d,  $J=2.38$  Hz, 1H) 10.26 (s, 1H).

## Example 158

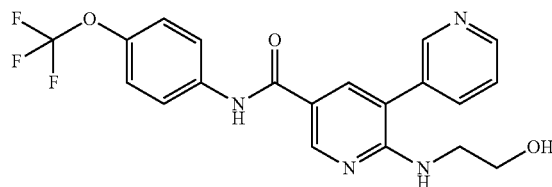
5'-Cyano-2-(ethyl(2-hydroxyethyl)amino)-N-(4-(trifluoromethoxy)phenyl)-[3,3'-bipyridine]-5-carboxamide



The title compound was prepared in an analogous fashion to that described in Example 151 using 5-bromo-6-(ethyl(2-hydroxyethyl)amino)-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 156.1) and 5-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)nicotinonitrile to afford a white solid. UPLC-MS (Condition 3)  $t_R=1.05$  min,  $m/z=472.2$   $[M+H]^+$ ,  $m/z=470.3$   $[M-H]^-$ ;  $^1H$ -NMR (400 MHz, DMSO- $d_6$ )  $\delta$  ppm 0.90 (t,  $J=6.97$  Hz, 3H) 3.14 (q,  $J=7.01$  Hz, 2H) 3.32-3.41 (m, 2H) 3.49 (q,  $J=5.71$  Hz, 2H) 4.62 (t,  $J=5.26$  Hz, 1H) 7.36 (d,  $J=8.80$  Hz, 2H) 7.77-7.92 (m, 2H) 8.10 (d,  $J=2.20$  Hz, 1H) 8.54 (t,  $J=1.96$  Hz, 1H) 8.78 (d,  $J=2.20$  Hz, 1H) 9.04 (dd,  $J=5.50$ , 2.08 Hz, 2H) 10.25 (s, 1H).

## Example 159

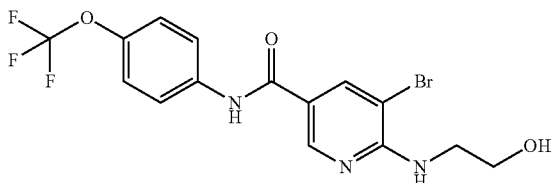
2-((2-Hydroxyethyl)amino)-N-(4-(trifluoromethoxy)phenyl)-[3,3'-bipyridine]-5-carboxamide



## 195

The title compound was prepared in an analogous fashion to that described in Example 152 using 5-bromo-6-((2-hydroxyethyl)amino)-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 159.1) and pyridin-3-ylboronic acid. LC-MS (Condition 6)  $t_R$ =0.88 min,  $m/z$ =419.0  $[M+H]^+$ .

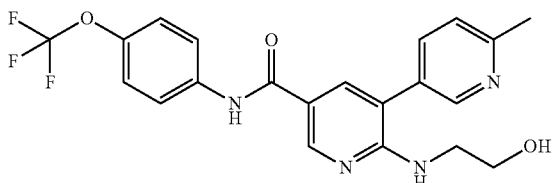
Stage 159.1 5-Bromo-6-((2-hydroxyethyl)amino)-N-(4-(trifluoromethoxy)phenyl)nicotinamide



A mixture of 5-bromo-6-chloro-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 12.2, 0.5 g, 1.264 mmol), 2-aminoethanol hydrochloride (0.123 g, 1.896 mmol), iPrOH (4 mL) and DIPEA (0.442 mL, 0.327 g, 2.53 mmol) were subjected to MW irradiation at 140° C. for 2 h. The vial was cooled to RT and the RM was poured into water (100 mL) and the resulting precipitate was collected by filtration. The obtained solid was washed with water (50 mL) and dried to afford the title compound without further purification. LC-MS (Condition 6)  $t_R$ =1.14 min,  $m/z$ =419.8  $[M+H]^+$ .

## Example 160

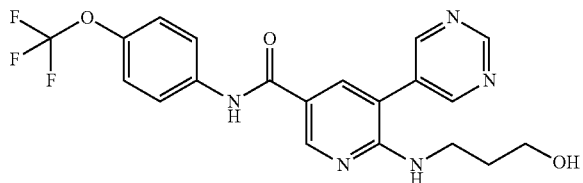
2-((2-Hydroxyethyl)amino)-6'-methyl-N-(4-(trifluoromethoxy)phenyl)-[3,3'-bipyridine]-5-carboxamide



The title compound was prepared in an analogous fashion to that described in Example 152 using 5-bromo-6-((2-hydroxyethyl)amino)-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 159.1) and (6-methylpyridin-3-yl)boronic acid. LC-MS (Condition 6)  $t_R$ =0.87 min,  $m/z$ =433.0  $[M+H]^+$ .

## Example 161

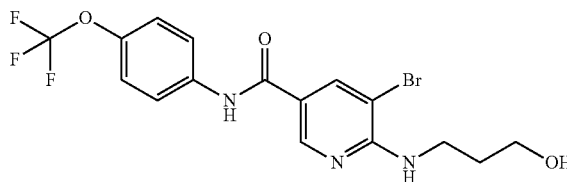
6-((3-Hydroxypropyl)amino)-5-(pyrimidin-5-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide



## 196

A mixture of 5-bromo-6-((3-hydroxypropyl)amino)-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 161.1, 72 mg, 0.15 mmol), pyrimidin-5-ylboronic acid (18.7 mg, 0.15 mmol) and  $Na_2CO_3$  (48 mg, 0.450 mmol) in a mixture of DME (3.2 mL), EtOH (0.43 mL) and water (0.64 mL) was flushed with argon for 5 min.  $Pd(PPh_3)_2Cl_2$  was added (5.3 mg, 0.0075 mmol) and the mixture was subjected to MW irradiation at 125° C. for 20 min. The vial was cooled to RT and the RM was evaporated to dryness under reduced pressure to give a residue that was triturated with THF and filtered. The filtrate was evaporated to dryness under reduced pressure and the crude product was purified by preparative LC-MS. TFA was removed using a SPE PL- $HCO_3$  (StratoSpheres™ VariPure IPE) cartridge to afford the title compound. UPLC-MS (Condition 8)  $t_R$ =2.05 min,  $m/z$ =434.1  $[M+H]^+$ ,  $m/z$ =432.1  $[M-H]^-$ .

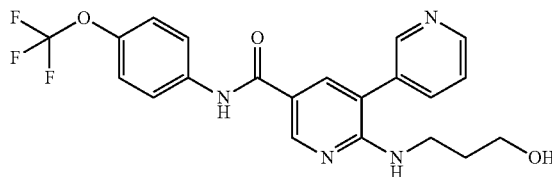
Stage 161.1 5-Bromo-6-((3-hydroxypropyl)amino)-N-(4-(trifluoromethoxy)phenyl)nicotinamide



A mixture of 5-bromo-6-chloro-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 12.2, 198 mg, 0.50 mmol), 3-aminopropan-1-ol (45 mg, 0.60 mmol), iPrOH (2 mL) and DIPEA (0.171 mL, 0.129 g, 1.0 mmol) were subjected to MW irradiation at 140° C. for 150 min. The vial was cooled to RT and the RM was evaporated to dryness under reduced pressure. No further purification was required to afford the title compound as an equimolar mixture with DIPEA hydrochloride. UPLC-MS (Condition 8)  $t_R$ =1.46 min,  $m/z$ =434.0  $[M+H]^+$ ,  $m/z$ =432.1  $[M-H]^-$ .

## Example 162

2-((3-Hydroxypropyl)amino)-N-(4-(trifluoromethoxy)phenyl)-[3,3'-bipyridine]-5-carboxamide

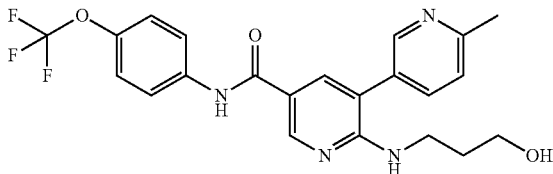


A mixture of 5-bromo-6-((3-hydroxypropyl)amino)-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 161.1, 72 mg, 0.15 mmol), pyridin-3-ylboronic acid (18.6 mg, 0.15 mmol) and  $Na_2CO_3$  (48 mg, 0.450 mmol) in a mixture of DME (3.2 mL), EtOH (0.43 mL) and water (0.64 mL) was flushed with argon for 5 min.  $Pd(PPh_3)_2Cl_2$  was added (5.3 mg, 0.0075 mmol) and the mixture subjected to MW irradiation at 125° C. for 20 min. The vial was cooled to RT and the RM was evaporated to dryness under reduced pressure to give a residue that was triturated with THF and filtered. The filtrate was evaporated to dryness under reduced pressure and the crude product was purified by preparative LC-MS. TFA was removed using a SPE PL- $HCO_3$  (StratoSpheres™ VariPure IPE) cartridge to afford the title compound. UPLC-MS (Condition 8)  $t_R$ =1.86 min,  $m/z$ =433.1  $[M+H]^+$ ,  $m/z$ =431.1  $[M-H]^-$ .

## 197

## Example 163

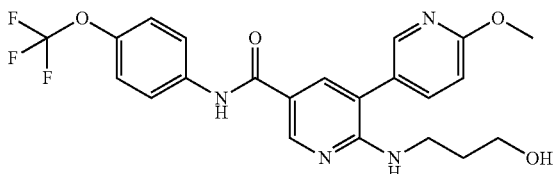
2-((3-Hydroxypropyl)amino)-6'-methyl-N-(4-(trifluoromethoxy)phenyl)-[3,3'-bipyridine]-5-carboxamide



A mixture of 5-bromo-6-((3-hydroxypropyl)amino)-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 161.1, 72 mg, 0.15 mmol), (6-methylpyridin-3-yl)boronic acid (20.7 mg, 0.15 mmol) and  $\text{Na}_2\text{CO}_3$  (48 mg, 0.450 mmol) in a mixture of DME (3.2 mL), EtOH (0.43 mL) and water (0.64 mL) was flushed with argon for 5 min.  $\text{Pd}(\text{PPh}_3)_2\text{Cl}_2$  was added (5.3 mg, 0.0075 mmol) and the mixture subjected to MW irradiation at 125° C. for 20 min. The vial was cooled to RT and the RM was evaporated to dryness under reduced pressure to give a residue that was triturated with THF and filtered. The filtrate was evaporated to dryness under reduced pressure and the crude product was purified by preparative LC-MS. TFA was removed using a SPE PL- $\text{HCO}_3$  (StratoSpheres™ VariPure IPE) cartridge to afford the title compound. UPLC-MS (Condition 8)  $t_R=1.87$  min,  $m/z=447.1$   $[\text{M}+\text{H}]^+$ ,  $m/z=445.2$   $[\text{M}-\text{H}]^-$ .

## Example 164

2-((3-Hydroxypropyl)amino)-6'-methoxy-N-(4-(trifluoromethoxy)phenyl)-[3,3'-bipyridine]-5-carboxamide



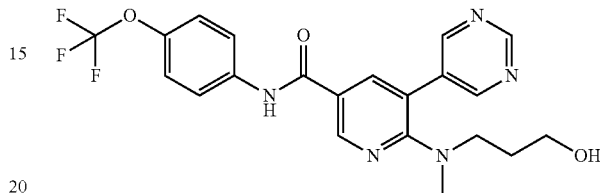
A mixture of 5-bromo-6-((3-hydroxypropyl)amino)-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 161.1, 72 mg, 0.15 mmol), (6-methoxypyridin-3-yl)boronic acid (23.1 mg, 0.15 mmol) and  $\text{Na}_2\text{CO}_3$  (48 mg, 0.450 mmol) in a mixture of DME (3.2 mL), EtOH (0.43 mL) and water (0.64 mL) was flushed with argon for 5 min.  $\text{Pd}(\text{PPh}_3)_2\text{Cl}_2$  was added (5.3 mg, 0.0075 mmol) and the mixture subjected to MW irradiation at 125° C. for 20 min. The vial was cooled to RT and the RM was evaporated to dryness under reduced pressure to give a residue that was triturated with THF and filtered. The filtrate was evaporated to dryness under reduced pressure and the crude product was purified by preparative LC-MS. TFA was removed using a SPE PL- $\text{HCO}_3$  (StratoSpheres™ VariPure

## 198

IPE) cartridge to afford the title compound. UPLC-MS (Condition 8)  $t_R=2.33$  min,  $m/z=463.1$   $[\text{M}+\text{H}]^+$ ,  $m/z=461.1$   $[\text{M}-\text{H}]^-$ .

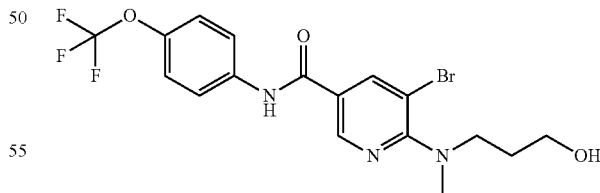
## Example 165

6-((3-Hydroxypropyl)(methyl)amino)-5-(pyrimidin-5-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide



A mixture of 5-bromo-6-((3-hydroxypropyl)(methyl)amino)-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 165.1, 90 mg, 0.185 mmol), pyrimidin-5-ylboronic acid (22.9 mg, 0.185 mmol) and  $\text{Na}_2\text{CO}_3$  (59 mg, 0.554 mmol) in a mixture of DME (4.0 mL), EtOH (0.54 mL) and water (0.80 mL) was flushed with argon for 5 min.  $\text{Pd}(\text{PPh}_3)_2\text{Cl}_2$  was added (6.5 mg, 0.0092 mmol) and the mixture was subjected to MW irradiation at 125° C. for 20 min. The vial was cooled to RT and the RM was evaporated to dryness under reduced pressure to give a residue that was triturated with THF and filtered. The filtrate was evaporated to dryness under reduced pressure and the crude product was purified by preparative LC-MS. TFA was removed using a SPE PL- $\text{HCO}_3$  (StratoSpheres™ VariPure IPE) cartridge to afford the title compound. UPLC-MS (Condition 8)  $t_R=2.26$  min,  $m/z=448.1$   $[\text{M}+\text{H}]^+$ ,  $m/z=446.2$   $[\text{M}-\text{H}]^-$ .

Stage 165.1 5-Bromo-6-((3-hydroxypropyl)(methyl)amino)-N-(4-(trifluoromethoxy)phenyl)nicotinamide



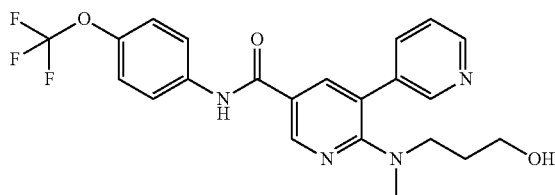
A mixture of 5-bromo-6-chloro-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 12.2, 237 mg, 0.60 mmol), 3-(methylamino)propan-1-ol (64 mg, 0.72 mmol), iPrOH (2.4 mL) and DIPEA (0.205 mL, 0.155 g, 1.2 mmol) were subjected to MW irradiation at 140° C. for 3 h. The vial was cooled to RT and the RM was evaporated to dryness under reduced pressure. No further purification was required to afford the title compound in an equimolar mixture with

## 199

DIPEA hydrochloride. LC-MS (Condition 5)  $t_R$ =1.18 min,  $m/z$ =448.0  $[M+H]^+$ ,  $m/z$ =446.0  $[M-H]^-$ .

## Example 166

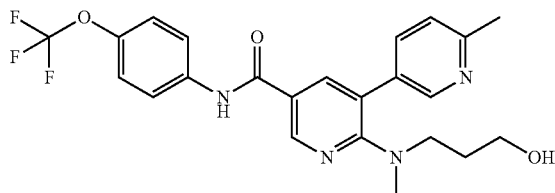
2-((3-Hydroxypropyl)(methyl)amino)-N-(4-(trifluoromethoxy)phenyl)-[3,3'-bipyridine]-5-carboxamide



A mixture of 5-bromo-6-((3-hydroxypropyl)(methyl)amino)-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 165.1, 90 mg, 0.185 mmol), pyridin-3-ylboronic acid (22.7 mg, 0.185 mmol) and  $Na_2CO_3$  (59 mg, 0.554 mmol) in a mixture of DME (4.0 mL), EtOH (0.54 mL) and water (0.80 mL) was flushed with argon for 5 min.  $Pd(PPh_3)_2Cl_2$  was added (6.5 mg, 0.0092 mmol) and the mixture was subjected to MW irradiation at 125° C. for 20 min. The vial was cooled to RT and the RM was evaporated to dryness under reduced pressure to give a residue that was triturated with THF and filtered. The filtrate was evaporated to dryness under reduced pressure and the crude product was purified by preparative LC-MS. TFA was removed using a SPE PL- $HCO_3$  (StratoSpheres™ VariPure IPE) cartridge to afford the title compound. UPLC-MS (Condition 8)  $t_R$ =2.05 min,  $m/z$ =447.1  $[M+H]^+$ ,  $m/z$ =445.2  $[M-H]^-$ .

## Example 167

2-((3-Hydroxypropyl)(methyl)amino)-6'-methyl-N-(4-(trifluoromethoxy)phenyl)-[3,3'-bipyridine]-5-carboxamide



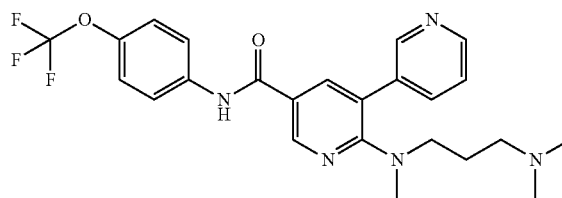
A mixture of 5-bromo-6-((3-hydroxypropyl)(methyl)amino)-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 165.1, 92 mg, 0.189 mmol), (6-methylpyridin-3-yl)boronic acid (25.9 mg, 0.189 mmol) and  $Na_2CO_3$  (60 mg, 0.566 mmol) in a mixture of DME (4.0 mL), EtOH (0.54 mL) and water (0.80 mL) was flushed with argon for 5 min.  $Pd(PPh_3)_2Cl_2$  was added (6.6 mg, 0.0094 mmol) and the mixture subjected to MW irradiation at 125° C. for 20 min. The vial was cooled to RT and the RM was evaporated to dryness under reduced pressure to give a residue that was triturated with THF and filtered. The filtrate was evaporated to dryness under

## 200

reduced pressure and the crude product was purified by preparative LC-MS. TFA was removed using a SPE PL- $HCO_3$  (StratoSpheres™ VariPure IPE) cartridge. Additional purification (Isolute Flash Silica gel cartridge, 5 g, elution of impurities with EtOAc, subsequent elution of product with MeOH) afforded the title compound. LC-MS (Condition 5)  $t_R$ =1.65 min,  $m/z$ =461.2  $[M+H]^+$ ,  $m/z$ =459.2  $[M-H]^-$ .

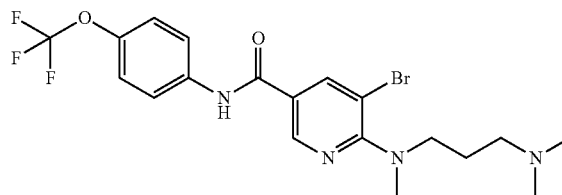
## Example 168

2-((3-(Dimethylamino)propyl)(methyl)amino)-N-(4-(trifluoromethoxy)phenyl)-[3,3'-bipyridine]-5-carboxamide



A mixture of 5-bromo-6-((3-(dimethylamino)propyl)(methyl)amino)-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 165.1, 88 mg, 0.185 mmol), pyridin-3-ylboronic acid (22.7 mg, 0.185 mmol) and  $Na_2CO_3$  (59 mg, 0.555 mmol) in a mixture of DME (4.0 mL), EtOH (0.54 mL) and water (0.80 mL) was flushed with argon for 5 min.  $Pd(PPh_3)_2Cl_2$  was added (6.5 mg, 0.0093 mmol) and the mixture was subjected to MW irradiation at 125° C. (MW irradiation) for 30 min. Additional pyridin-3-ylboronic acid (22.7 mg, 0.185 mmol),  $Na_2CO_3$  (59 mg, 0.555 mmol) and  $Pd(PPh_3)_2Cl_2$  (6.5 mg, 0.0093 mmol) were added and the mixture stirred at 125° C. for further 30 min. The vial was cooled to RT and the RM was evaporated to dryness under reduced pressure to give a residue that was triturated with THF and filtered. The filtrate was evaporated to dryness under reduced pressure and the crude product was purified by preparative LC-MS. TFA was removed using a SPE PL- $HCO_3$  (StratoSpheres™ VariPure IPE) cartridge to afford the title compound. LC-MS (Condition 6)  $t_R$ =1.33 min,  $m/z$ =474.0  $[M+H]^+$ .

Stage 168.1 5-Bromo-6-((3-(dimethylamino)propyl)(methyl)amino)-N-(4-(trifluoromethoxy)phenyl)nicotinamide



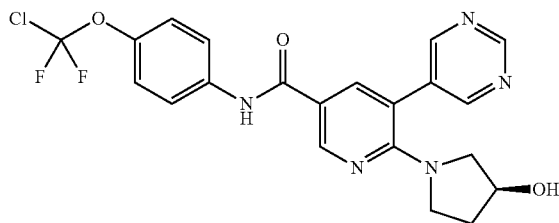
A mixture of 5-bromo-6-chloro-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 12.2, 237 mg, 0.60 mmol), N1,N1,N3-trimethylpropane-1,3-diamine (84 mg, 0.72 mmol), iPrOH (2.4 mL) and DIPEA (0.205 mL, 0.155 g, 1.2

## 201

mmol) were subjected to MW irradiation at 140° C. for 120 min. The vial was cooled to RT and the RM was evaporated to dryness under reduced pressure. No further purification was required to afford the title compound in an equimolar mixture with DIPEA hydrochloride. UPLC-MS (Condition 8)  $t_R$ =2.18 min,  $m/z$ =475.1 [M+H]<sup>+</sup>,  $m/z$ =473.1 [M-H]<sup>-</sup>.

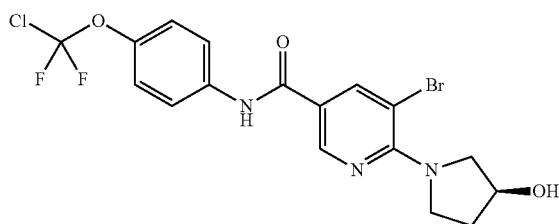
## Example 169

(S)—N-(4-(Chlorodifluoromethoxy)phenyl)-6-(3-hydroxypyrrolidin-1-yl)-5-(pyrimidin-5-yl)nicotinamide



(S)-5-Bromo-N-(4-(chlorodifluoromethoxy)phenyl)-6-(3-hydroxypyrrolidin-1-yl)nicotinamide (Stage 169.1, (116 mg, 0.25 mmol) and pyrimidin-5-ylboronic acid (62 mg, 0.5 mmol) were dissolved in DME (1 mL). A solution of 2 M Na<sub>2</sub>CO<sub>3</sub> (0.375 mL, 0.75 mmol) was added, the mixture was flushed with argon, PdCl<sub>2</sub>(dppf) (9 mg, 0.013 mmol) was added and the RM subjected to MW irradiation at 100° C. for 2 h. After cooling to RT, the RM was dissolved in EtOAc and washed with brine. The organic phase was dried over Na<sub>2</sub>SO<sub>4</sub> and evaporated under reduced pressure to give a residue that was purified flash chromatography (RediSep® Silica gel column, EtOAc/EtOAc-MeOH (98:2)), from 50% to 100% EtOAc-MeOH (98:2)) and treated with Si-Thiol (80 mg) in MeOH to afford the title compound as a white crystalline powder. HPLC (Condition 4)  $t_R$ =4.71 min, HPLC Chiral (CHIRALPAK® AD-H, 250×4.6 mm, eluent: EtOH/MeOH (50:50), 0.5 mL/min, UV 210 nm)  $t_R$ =60.52 min, UPLC-MS (Condition 3)  $t_R$ =0.95 min,  $m/z$ =462.2 [M+H]<sup>+</sup>; <sup>1</sup>H-NMR (400 MHz, DMSO-d<sub>6</sub>) δ ppm 1.68-1.78 (m, 1H) 1.80-1.90 (m, 1H) 2.82-2.92 (m, 1H) 3.15-3.26 (m, 2H) 3.33-3.41 (m, 1H) 4.15-4.24 (m, 1H) 4.86 (d, J=3.52 Hz, 1H) 7.33 (d, J=8.21 Hz, 2H) 7.84 (d, J=9.38 Hz, 2H) 8.03-8.13 (m, 1H) 8.78 (m, J=2.35, 0.78 Hz, 1H) 8.87 (s, 2H) 9.18 (d, J=0.78 Hz, 1H) 10.16 (s, 1H).

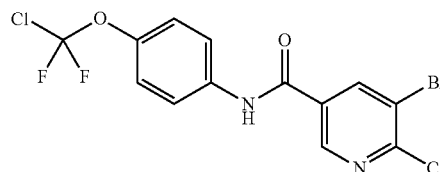
Stage 169.1 (S)-5-Bromo-N-(4-(chlorodifluoromethoxy)phenyl)-6-(3-hydroxypyrrolidin-1-yl)nicotinamide



## 202

DIPEA (190 μL, 1.1 mmol) was added to a solution of 5-bromo-6-chloro-N-(4-(chlorodifluoromethoxy)phenyl)nicotinamide (Stage 169.2, 206 mg, 0.5 mmol) and (S)-pyrrolidin-3-ol (52.3 mg, 0.6 mmol) in iPrOH (500 μL) in a vial, which was sealed and heated at 140° C. for 1 h. After cooling at RT, the RM was dissolved in EtOAc, washed with 0.5 M aq. HCl and brine, dried over Na<sub>2</sub>SO<sub>4</sub> and the solvent was evaporated off under reduced pressure to give the crude product which was purified by flash chromatography (RediSep® Silica gel column, n-heptane/EtOAc, from 20% to 100% EtOAc) to afford the title compound as a white crystalline powder. HPLC (Condition 4)  $t_R$ =5.59 min, UPLC-MS (Condition 3)  $t_R$ =1.17 min,  $m/z$ =462.0/464.1 [M+H]<sup>+</sup>.

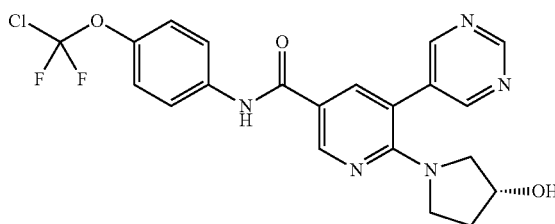
Stage 169.2 5-Bromo-6-chloro-N-(4-(chlorodifluoromethoxy)phenyl)-nicotinamide



5-Bromo-6-chloro-nicotinic acid (8 g, 33.8 mmol) was suspended in toluene (70 mL). DMF (0.77 mL, 10.15 mmol) was added followed by slow addition of SOCl<sub>2</sub> (7.4 mL, 102 mmol) and the RM was stirred for 1 h at 80° C. After cooling at RT, the toluene was evaporated off under reduced pressure. The residue was dissolved in THF (70 mL) and cooled to -10-15° C. and treated with DIPEA (11.8 mL, 67.7 mmol) followed by the slow addition of a solution of 4-(chlorodifluoromethoxy)aniline (6.88 g, 35.5 mmol) in THF (70 mL) over 10 min. The RM was allowed to warm at RT and stirred for 1 h, the solvent was evaporated off under reduced pressure. The residue was dissolved in TBME, the solution was washed with 1 M HCl, 10% aq. NaHCO<sub>3</sub> and brine, dried over Na<sub>2</sub>SO<sub>4</sub> and concentrated under reduced pressure until crystallisation started. n-Heptane was then added and the product was filtered and dried to afford the title compound as a beige crystalline powder. HPLC (Condition 4)  $t_R$ =6.46 min, UPLC-MS (Condition 3)  $t_R$ =1.29 min,  $m/z$ =411 [M+H]<sup>+</sup>.

## Example 170

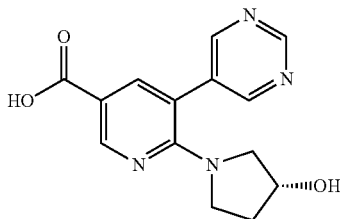
(R)—N-(4-(Chlorodifluoromethoxy)phenyl)-6-(3-hydroxypyrrolidin-1-yl)-5-(pyrimidin-5-yl)nicotinamide



## 203

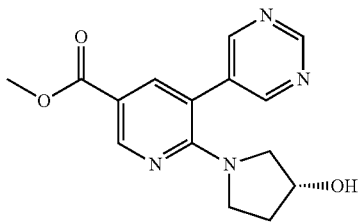
(R)-6-(3-Hydroxypyrrolidin-1-yl)-5-(pyrimidin-5-yl) nicotinic acid (Stage 170.1, 57.3 mg, 0.2 mmol), HOBT (43.5, 0.284 mmol) and EDC (42.2 mg, 0.22 mmol) were dissolved in 0.3 M NMM in DMF (0.8 mL) at RT. 4-(Chlorodifluoromethoxy)aniline (36.8 mg, 0.19 mmol) was added and the RM was stirred for 5 h. The RM was then diluted with EtOAc and washed with 10% NaHCO<sub>3</sub>. The organic layer was dried over Na<sub>2</sub>SO<sub>4</sub>, filtered and evaporated to dryness under reduced pressure. The residue was purified by flash chromatography (RediSep® Silica gel column, DCM/MeOH, from 2 to 5% MeOH) and treated with Si-Thiol (50 mg) in MeOH to afford the title compound. HPLC Chiral (CHIRALPAK® AD-H, 250×4.6 mm, eluent: EtOH/MeOH (50:50), 0.5 mL/min, UV 210 nm)  $t_R$ =21.89 min, UPLC-MS (Condition 3)  $t_R$ =0.95 min,  $m/z$ =462.2/464.2 [M+H]<sup>+</sup>; <sup>1</sup>H-NMR (400 MHz, DMSO-*d*<sub>6</sub>)  $\delta$  ppm 1.67-1.78 (m, 1H) 1.80-1.89 (m, 1H) 2.87 (d,  $J$ =11.34 Hz, 1H) 3.21 (m,  $J$ =11.10, 4.90 Hz, 2H) 3.33-3.44 (m, 1H) 4.12-4.24 (m, 1H) 4.87 (d,  $J$ =3.52 Hz, 1H) 7.33 (d,  $J$ =8.60 Hz, 2H) 7.77-7.89 (m, 2H) 8.08 (d,  $J$ =2.35 Hz, 1H) 8.78 (d,  $J$ =2.35 Hz, 1H) 8.88 (s, 2H) 9.18 (s, 1H) 10.17 (s, 1H).

Stage 170.1 (R)-6-(3-Hydroxypyrrolidin-1-yl)-5-(pyrimidin-5-yl)nicotinic acid



(R)-Methyl 6-(3-hydroxypyrrolidin-1-yl)-5-(pyrimidin-5-yl)nicotinate (Stage 170.2, 640 mg, 4.26 mmol) was added to 2 M NaOH (2 mL) and stirred 30 min at RT until complete dissolution. The RM was acidified (pH=2) with 2 M HCl and the solid which precipitated was filtered to afford the title compound as a white crystalline powder. HPLC (Condition 4)  $t_R$ =2.19 min, UPLC-MS (Condition 7)  $m/z$ =287.1 [M+H]<sup>+</sup>.

Stage 170.2 (R)-Methyl 6-(3-hydroxypyrrolidin-1-yl)-5-(pyrimidin-5-yl)nicotinate

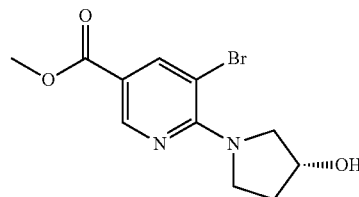


(R)-Methyl 5-bromo-6-(3-hydroxypyrrolidin-1-yl)nicotinate (Stage 170.3, 930 mg, 3.1 mmol) and pyrimidin-5-ylboronic acid (765 mg, 6.2 mmol) were dissolved in a solution of DME (5 mL) and EtOH (0.7 mL). A solution of 2 M Na<sub>2</sub>CO<sub>3</sub>

## 204

(4.63 mL, 9.26 mmol) was added, the mixture was flushed with argon, Pd(PPh<sub>3</sub>)<sub>2</sub>Cl<sub>2</sub> (260 mg, 0.371 mmol) was added and the RM was stirred at 95° C. in a pressure safe vial for 1.5 h. After cooling at RT, the RM was treated with brine and extracted with EtOAc. The combined extracts were dried over Na<sub>2</sub>SO<sub>4</sub> and the solvent was evaporated off under reduced pressure to give a residue that was purified by flash chromatography (RediSep® Silica gel column, (DCM/MeOH 98:2)/MeOH, from 0 to 5% MeOH) and treated with Si-Thiol (1 g) in MeOH to afford the title compound as a grey foamy powder. HPLC (Condition 4)  $t_R$ =2.95 min, UPLC-MS (Condition 7)  $m/z$ =301.1 [M+H]<sup>+</sup>.

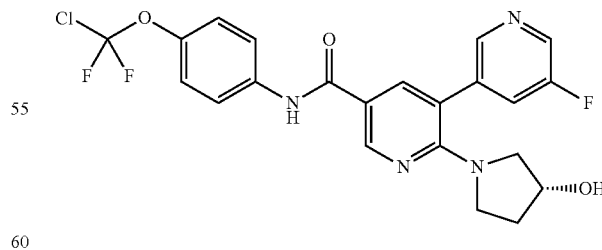
Stage 170.3 (R)-Methyl 5-bromo-6-(3-hydroxypyrrolidin-1-yl)nicotinate



Methyl-5-bromo-6-chloronicotinate (1 g, 4 mmol) and (R)-pyrrolidin-3-ol (418 mg, 4.8 mmol) were dissolved in iPrOH (4 mL). DIPEA (0.9 mL, 5.2 mmol) was added and the RM mixture was heated at 140° C. for 1 h. After cooling at RT, the RM was dissolved in EtOAc and washed with brine. The organic phase was dried over Na<sub>2</sub>SO<sub>4</sub> and the solvent was evaporated off under reduced pressure to give a residue that was purified by flash chromatography (RediSep® Silica gel column, n-hexane/EtOAc, from 50% to 80% EtOAc) to afford the title compound as a brown-yellow oil. HPLC (Condition 4)  $t_R$ =4.11 min, UPLC-MS (Condition 7)  $m/z$ =301 [M+H]<sup>+</sup>.

## Example 171

(R)-N-(4-(Chlorodifluoromethoxy)phenyl)-5'-fluoro-2-(3-hydroxypyrrolidin-1-yl)-[3,3'-bipyridine]-5-carboxamide

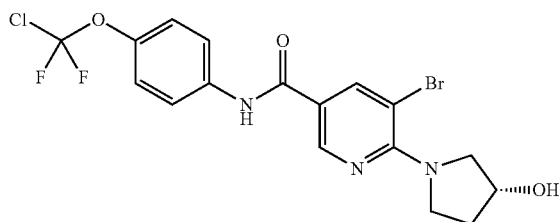


The title compound was prepared in an analogous fashion to that described in Example 151 using (R)-5-bromo-N-(4-(chlorodifluoromethoxy)phenyl)-6-(3-hydroxypyrrolidin-1-yl)nicotinamide (Stage 171.1) and (5-fluoropyridin-3-yl)boronic acid to afford a white solid. UPLC-MS (Condition 3)  $t_R$ =1.03 min,  $m/z$ =479.1 [M+H]<sup>+</sup>,  $m/z$ =523.0 [M+ formic

## 205

acid-H];  $^1\text{H-NMR}$  (400 MHz,  $\text{DMSO-d}_6$ )  $\delta$  ppm 1.68-1.79 (m, 1H) 1.80-1.91 (m, 1H) 2.87 (d,  $J=11.17$  Hz, 1H) 3.17-3.29 (m, 2H) 3.35-3.45 (m, 1H) 4.20 (br. s, 1H) 4.89 (d,  $J=2.51$  Hz, 1H) 7.35 (d,  $J=9.16$  Hz, 2H) 7.82-7.89 (m, 3H) 8.08 (d,  $J=2.38$  Hz, 1H) 8.51 (t,  $J=1.63$  Hz, 1H) 8.60 (d,  $J=2.76$  Hz, 1H) 8.78 (d,  $J=2.38$  Hz, 1H) 10.20 (s, 1H).

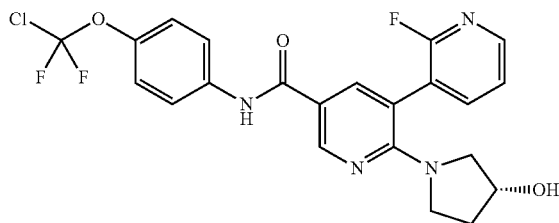
Stage 171.1 (R)-5-Bromo-N-(4-(chlorodifluoromethoxy)phenyl)-6-(3-hydroxypyrrolidin-1-yl)nicotinamide



5-Bromo-6-chloro-N-(4-(chlorodifluoromethoxy)phenyl)nicotinamide (Stage 169.2, 206 mg, 0.5 mmol) and (R)-pyrrolidin-3-ol (52.3 mg, 0.6 mmol) were dissolved in  $i\text{PrOH}$  (1 mL). DIPEA (192  $\mu\text{L}$ , 1.1 mmol) was added and the RM mixture was stirred at  $140^\circ\text{C}$ . for 1 h in a sealed vial. After cooling at RT, the RM was dissolved in  $\text{EtOAc}$ , washed with 0.5 M  $\text{HCl}$  and brine, dried over  $\text{Na}_2\text{SO}_4$  and the solvent was evaporated off under reduced pressure to give a crude product which was purified by flash chromatography (RediSep® Silica gel column,  $n$ -heptane/ $\text{EtOAc}$  from 20% to 100%  $\text{EtOAc}$ ). The resulting product was triturated under  $n$ -heptane, filtered and dried to afford the title compound as a white crystalline powder. HPLC (Condition 4)  $t_R=5.68$  min, UPLC-MS (Condition 3)  $t_R=1.15$  min,  $m/z=462.1$   $[\text{M}+\text{H}]^+$ .

## Example 172

(R)-N-(4-(Chlorodifluoromethoxy)phenyl)-2'-fluoro-2-(3-hydroxypyrrolidin-1-yl)-[3,3'-bipyridine]-5-carboxamide



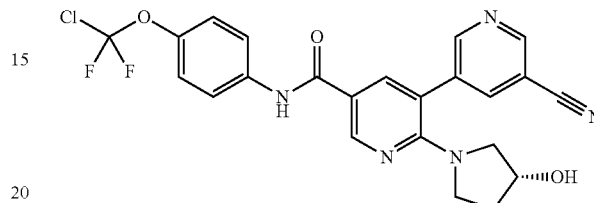
The title compound was prepared in an analogous fashion to that described in Example 133 using (R)-5-bromo-N-(4-(chlorodifluoromethoxy)phenyl)-6-(3-hydroxypyrrolidin-1-yl)nicotinamide (Stage 171.1) and (2-fluoropyridin-3-yl)boronic acid to afford a white solid. HPLC (Condition 4)  $t_R=5.22$  min, UPLC-MS (Condition 3)  $t_R=1.07$  min,  $m/z=479.3$   $[\text{M}+\text{H}]^+$ ;  $^1\text{H-NMR}$  (400 MHz,  $\text{DMSO-d}_6$ )  $\delta$  ppm 1.63-1.76 (m, 1H) 1.78-1.88 (m, 1H) 2.84-2.97 (m, 1H) 3.15 (m,  $J=4.70$  Hz, 2H) 3.31-3.43 (m, 1H) 4.14-4.24 (m, 1H) 4.86

## 206

(br. s, 1H) 7.32 (d,  $J=8.99$  Hz, 2H) 7.42-7.54 (m, 1H) 7.76-7.89 (m, 2H) 8.00 (d,  $J=2.35$  Hz, 1H) 8.03-8.13 (m, 1H) 8.28 (d,  $J=4.69$  Hz, 1H) 8.78 (d,  $J=2.35$  Hz, 1H) 10.15 (s, 1H).

## Example 173

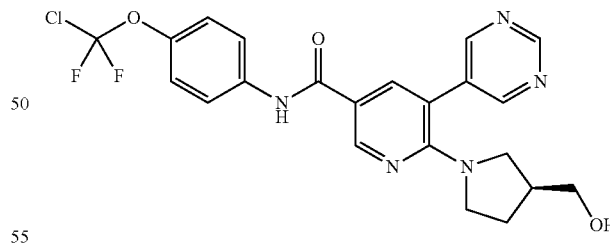
(R)-N-(4-(Chlorodifluoromethoxy)phenyl)-5'-cyano-2-(3-hydroxypyrrolidin-1-yl)-[3,3'-bipyridine]-5-carboxamide



The title compound was prepared in an analogous fashion to that described in Example 151 using (R)-5-bromo-N-(4-(chlorodifluoromethoxy)phenyl)-6-(3-hydroxypyrrolidin-1-yl)nicotinamide (Stage 171.1) and 5-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)nicotinonitrile to afford a white solid. UPLC-MS (Condition 3)  $t_R=1.02$  min,  $m/z=486.2$   $[\text{M}+\text{H}]^+$ ,  $m/z=530.0$   $[\text{M}+\text{formic acid-H}]^+$ ;  $^1\text{H-NMR}$  (400 MHz,  $\text{DMSO-d}_6$ )  $\delta$  ppm 1.69-1.80 (m, 1H) 1.80-1.91 (m, 1H) 2.85 (d,  $J=11.42$  Hz, 1H) 3.16-3.26 (m, 2H) 3.35-3.43 (m, 1H) 4.20 (br. s, 1H) 4.90 (d,  $J=3.64$  Hz, 1H) 7.35 (d,  $J=9.16$  Hz, 2H) 7.82-7.89 (m, 2H) 8.10 (d,  $J=2.38$  Hz, 1H) 8.41 (t,  $J=2.07$  Hz, 1H) 8.79 (d,  $J=2.38$  Hz, 1H) 8.90 (d,  $J=2.26$  Hz, 1H) 9.03 (d,  $J=1.88$  Hz, 1H) 10.20 (s, 1H).

## Example 174

(S)-N-(4-(Chlorodifluoromethoxy)phenyl)-6-(3-(hydroxymethyl)pyrrolidin-1-yl)-5-(pyrimidin-5-yl)nicotinamide

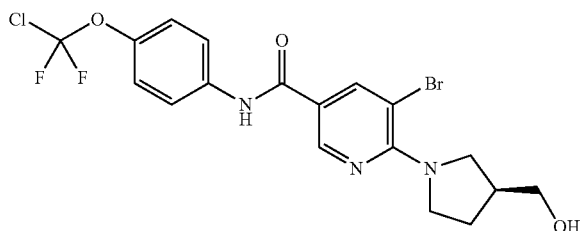


The title compound was prepared in an analogous fashion to that described in Example 169 using (S)-5-bromo-N-(4-(chlorodifluoromethoxy)phenyl)-6-(3-(hydroxymethyl)pyrrolidin-1-yl)nicotinamide (Stage 174.1) and pyrimidin-5-ylboronic acid to afford a white solid. HPLC (Condition 4)  $t_R=4.93$  min, UPLC-MS (Condition 3)  $t_R=0.97$  min,  $m/z=476.3$   $[\text{M}+\text{H}]^+$ ;  $^1\text{H-NMR}$  (400 MHz,  $\text{DMSO-d}_6$ )  $\delta$  ppm 1.57 (m,  $J=12.10$ , 7.80 Hz, 1H) 1.84 (m,  $J=11.90$ , 6.10 Hz, 1H) 2.12-2.31 (m, 1H) 2.95 (dd,  $J=10.56$ , 7.04 Hz, 1H) 3.08-3.44 (m, 5H) 4.60 (t,  $J=5.08$  Hz, 1H) 7.33 (d,  $J=8.21$  Hz, 2H)

## 207

7.84 (d, J=9.38 Hz, 2H) 8.07 (d, J=2.35 Hz, 1H) 8.78 (d, J=2.35 Hz, 1H) 8.88 (s, 2H) 9.17 (s, 1H) 10.16 (s, 1H).

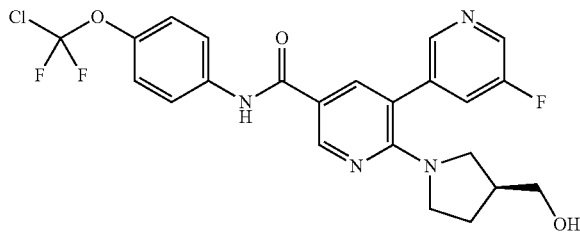
Stage 174.1 (S)-5-Bromo-N-(4-(chlorodifluoromethoxy)phenyl)-6-(3-(hydroxymethyl)pyrrolidin-1-yl)nicotinamide



The title compound was prepared in an analogous fashion to that described in Stage 33.1 using 5-bromo-6-chloro-N-(4-(chlorodifluoromethoxy)phenyl)nicotinamide (Stage 169.2) and (S)-1-pyrrolidin-3-yl-methanol to afford an off-white crystalline solid. HPLC (Condition 4)  $t_R$ =5.82 min, UPLC-MS (Condition 3)  $t_R$ =1.14 min,  $m/z$ =476.2/478.3 [M+H]<sup>+</sup>.

## Example 175

(S)-N-(4-(Chlorodifluoromethoxy)phenyl)-5'-fluoro-2-(3-(hydroxymethyl)pyrrolidin-1-yl)-[3,3'-bipyridine]-5-carboxamide



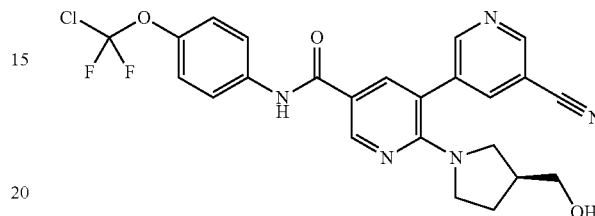
The title compound was prepared in an analogous fashion to that described in Example 169 using (S)-5-bromo-N-(4-(chlorodifluoromethoxy)phenyl)-6-(3-(hydroxymethyl)pyrrolidin-1-yl)nicotinamide (Stage 174.1) and 3-fluoro-5-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)pyridine to afford an off-white solid. HPLC (Condition 4)  $t_R$ =5.29 min, UPLC-MS (Condition 3)  $t_R$ =1.06 min,  $m/z$ =493.3 [M+H]<sup>+</sup>; <sup>1</sup>H-NMR (400 MHz, DMSO-d<sub>6</sub>)  $\delta$  ppm 1.47-1.63 (m, 1H) 1.83 (m, J=5.90 Hz, 1H) 2.14-2.28 (m, 1H) 2.96 (dd, J=10.95, 7.04 Hz, 1H) 3.10-3.38 (m, 5H) 4.60 (t, J=5.08 Hz, 1H) 7.32

## 208

(d, J=8.21 Hz, 2H) 7.77-7.88 (m, 3H) 8.05 (d, J=1.00 Hz, 1H) 8.50 (s, 1H) 8.57 (d, J=1.96 Hz, 1H) 8.76 (d, J=1.00 Hz, 1H) 10.16 (s, 1H).

## Example 176

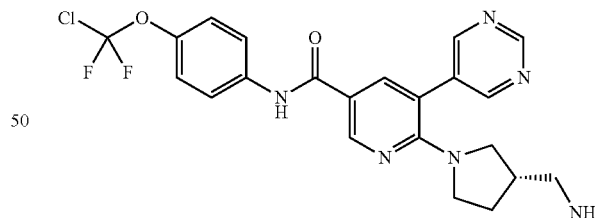
(S)-N-(4-(Chlorodifluoromethoxy)phenyl)-5'-cyano-2-(3-(hydroxymethyl)pyrrolidin-1-yl)-[3,3'-bipyridine]-5-carboxamide



The title compound was prepared in an analogous fashion to that described in Example 151 using (S)-5-bromo-N-(4-(chlorodifluoromethoxy)phenyl)-6-(3-(hydroxymethyl)pyrrolidin-1-yl)nicotinamide (Stage 174.1) and 5-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)nicotinonitrile to afford a yellow solid. UPLC-MS (Condition 3)  $t_R$ =1.05 min,  $m/z$ =498.5 [M+H]<sup>+</sup>,  $m/z$ =500.0 [M-H]<sup>-</sup>; <sup>1</sup>H-NMR (400 MHz, DMSO-d<sub>6</sub>)  $\delta$  ppm 1.51-1.66 (m, 1H) 1.78-1.92 (m, 1H) 2.17-2.30 (m, 1H) 2.96 (dd, J=11.00, 6.85 Hz, 1H) 3.11-3.28 (m, 4H) 3.32-3.42 (m, 1H) 4.60 (t, J=5.26 Hz, 1H) 7.34 (d, J=9.05 Hz, 2H) 7.81-7.91 (m, 2H) 8.08 (d, J=2.20 Hz, 1H) 8.40 (t, J=2.08 Hz, 1H) 8.79 (d, J=2.45 Hz, 1H) 8.91 (d, J=2.20 Hz, 1H) 9.01 (d, J=1.96 Hz, 1H) 10.16 (s, 1H).

## Example 177

(S)-6-(3-(Aminomethyl)pyrrolidin-1-yl)-N-(4-(chlorodifluoromethoxy)phenyl)-5-(pyrimidin-5-yl)nicotinamide

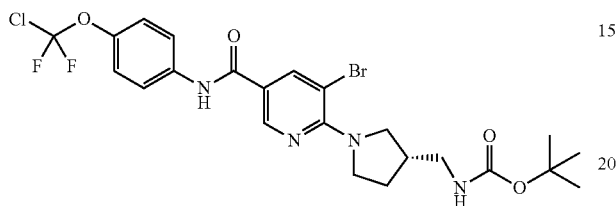


(S)-Tert-Butyl ((1-(3-bromo-5-((4-(chlorodifluoromethoxy)phenyl)carbamoyl)-pyridin-2-yl)pyrrolidin-3-yl)methyl)carbamate (Stage 177.1, 120 mg, 0.209 mmol) was dissolved in DCM (1.0 mL), TFA (0.5 mL) was added and stirred at 0° C. for 1 h. The RM was poured into 25 mL of Na<sub>2</sub>CO<sub>3</sub> 10%, then extracted with EtOAc. The combined extracts were dried over Na<sub>2</sub>SO<sub>4</sub> and evaporated to dryness under reduced pressure to afford the title compound as an off-white solid. HPLC (Condition 4)  $t_R$ =4.24 min, UPLC-MS (Condition 3)  $t_R$ =0.80 min,  $m/z$ =475.3 [M+H]<sup>+</sup>; <sup>1</sup>H-NMR (400 MHz, DMSO-d<sub>6</sub>)  $\delta$  ppm 1.46-1.63 (m, 1H) 1.81-1.97

## 209

(m, 1H) 2.10-2.21 (m, 1H) 2.57 (m, J=7.40, 7.40 Hz, 2H) 2.91-3.03 (m, 1H) 3.07-3.17 (m, 2H) 3.30 (s, 3H) 7.33 (d, J=8.99 Hz, 2H) 7.78-7.89 (m, 2H) 8.09 (d, J=2.35 Hz, 1H) 8.77 (d, J=2.35 Hz, 1H) 8.88 (s, 2H) 9.18 (s, 1H) 10.16 (s, 1H).

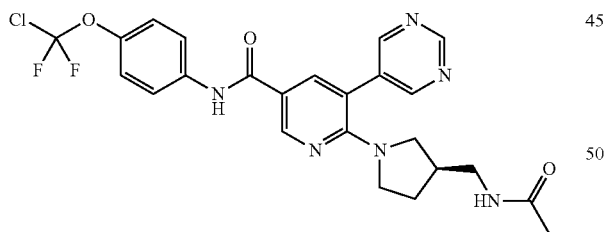
Stage 177.1 (S)-tert-Butyl (0-(3-bromo-5-((4-(chlorodifluoromethoxy)phenyl)-carbamoyl)pyridin-2-yl)pyrrolidin-3-yl)methylcarbamate



The title compound was prepared in an analogous fashion to that described in Example 169 using 5-bromo-6-chloro-N-(4-(chlorodifluoromethoxy)phenyl)nicotinamide (Stage 169.2) and (R)-1-pyrrolidin-3-ylmethyl-carbamic acid tert-butyl ester to afford a crystalline solid. HPLC (Condition 4)  $t_R$ =6.09 min, UPLC-MS (Condition 3)  $t_R$ =1.36 min,  $m/z$ =577.2  $[M+H]^+$ .

## Example 178

(R)-6-(3-(Acetamidomethyl)pyrrolidin-1-yl)-N-(4-(chlorodifluoromethoxy)phenyl)-5-(pyrimidin-5-yl)nicotinamide



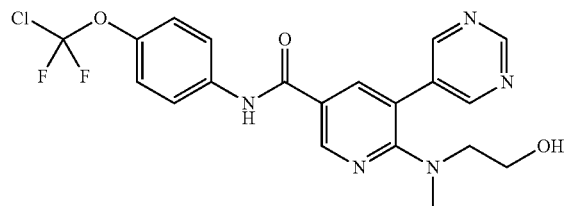
(S)-6-(3-(Aminomethyl)pyrrolidin-1-yl)-N-(4-(chlorodifluoromethoxy)phenyl)-5-(pyrimidin-5-yl)nicotinamide (Example 177, 30 mg, 0.063 mmol) was dissolved in dioxane (0.5 mL), acetic anhydride (7.09 mg, 0.069 mmol) was added and the RM was stirred for 3 h at RT. The RM was poured into 15 mL of  $Na_2CO_3$  10%, then extracted with EtOAc. The combined organic layers were dried over  $Na_2SO_4$  and evaporated to dryness under reduced pressure, dissolved in MeOH, evaporated and dried under HV to afford the title compound as an off-white solid. HPLC (Condition 4)  $t_R$ =4.95 min, UPLC-MS (Condition 3)  $t_R$ =0.93 min,  $m/z$ =517.3  $[M+H]^+$ ;

## 210

$^1H$ -NMR (400 MHz, DMSO- $d_6$ )  $\delta$  ppm 1.44-1.60 (m, 1H) 1.75 (s, 3H) 1.79-1.93 (m, 1H) 2.15-2.31 (m, 1H) 2.86-3.02 (m, 3H) 3.04-3.20 (m, 2H) 3.23-3.36 (m, 1H) 7.33 (d, J=8.21 Hz, 2H) 7.77-7.93 (m, 3H) 8.08 (d, J=2.35 Hz, 1H) 8.77 (d, J=0.78 Hz, 1H) 8.87 (s, 2H) 9.17 (s, 1H) 10.16 (s, 1H).

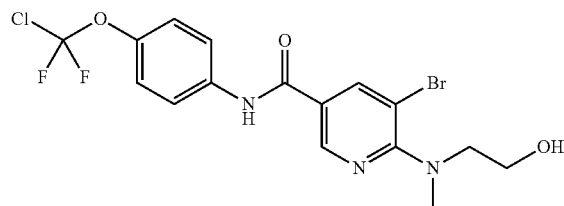
## Example 179

N-(4-(Chlorodifluoromethoxy)phenyl)-6-((2-hydroxyethyl)(methyl)amino)-5-(pyrimidin-5-yl)nicotinamide



The title compound was prepared in an analogous fashion to that described in Example 169 using 5-bromo-N-(4-(chlorodifluoromethoxy)phenyl)-6-((2-hydroxyethyl)(methyl)amino)nicotinamide (Stage 179.1) and pyrimidin-5-ylboronic acid to afford a white crystalline solid. HPLC (Condition 4)  $t_R$ =5.02 min, UPLC-MS (Condition 3)  $t_R$ =0.96 min,  $m/z$ =450.3  $[M+H]^+$ ;  $^1H$ -NMR (400 MHz, DMSO- $d_6$ )  $\delta$  ppm 2.69 (s, 3H) 3.38-3.65 (m, 4H) 4.67 (t, J=5.08 Hz, 1H) 7.34 (d, J=8.21 Hz, 2H) 7.85 (d, J=8.99 Hz, 2H) 8.13 (d, J=2.35 Hz, 1H) 8.75 (d, J=1.56 Hz, 1H) 8.95 (s, 2H) 9.17 (s, 1H) 10.22 (s, 1H).

Stage 179.1 5-Bromo-N-(4-(chlorodifluoromethoxy)phenyl)-6-((2-hydroxyethyl)(methyl)amino)nicotinamide



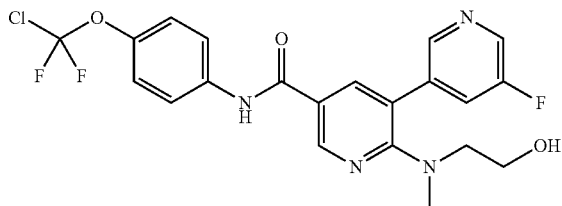
The title compound was prepared in an analogous fashion to that described in Stage 33.1 using 5-bromo-6-chloro-N-(4-(chlorodifluoromethoxy)phenyl)nicotinamide (Stage 169.2) and 2-methylamino-ethanol to afford as a white crystalline

## 211

solid. HPLC (Condition 4)  $t_R$ =5.72 min, UPLC-MS (Condition 3)  $t_R$ =1.14 min,  $m/z$ =452.2  $[M+H]^+$ .

## Example 180

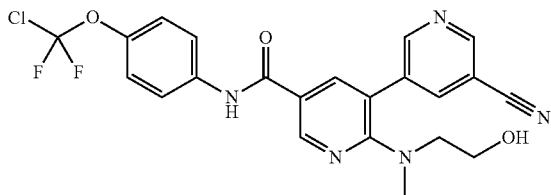
N-(4-(Chlorodifluoromethoxy)phenyl)-5'-fluoro-2-((2-hydroxyethyl)(methyl)amino)-[3,3'-bipyridine]-5-carboxamide



The title compound was prepared in an analogous fashion to that described in Example 169 using 5-bromo-N-(4-(chlorodifluoromethoxy)phenyl)-6-((2-hydroxyethyl)(methyl)amino)nicotinamide (Stage 179.1) and 3-fluoro-5-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)pyridine to afford an off-white foam. HPLC (Condition 4)  $t_R$ =5.51 min, UPLC-MS (Condition 3)  $t_R$ =1.07 min,  $m/z$ =467.3  $[M+H]^+$ ;  $^1H$ -NMR (400 MHz, DMSO- $d_6$ )  $\delta$  ppm 2.69 (s, 3H) 3.39-3.61 (m, 4H) 4.65 (t, J=5.08 Hz, 1H) 7.33 (d, J=8.99 Hz, 2H) 7.77-7.94 (m, 3H) 8.11 (d, J=2.35 Hz, 1H) 8.50-8.63 (m, 2H) 8.74 (d, J=2.35 Hz, 1H) 10.21 (s, 1H).

## Example 181

N-(4-(Chlorodifluoromethoxy)phenyl)-5'-cyano-2-((2-hydroxyethyl)(methyl)amino)-[3,3'-bipyridine]-5-carboxamide



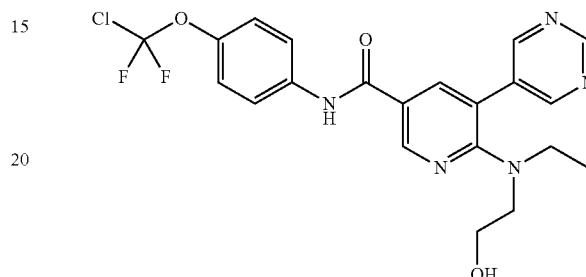
The title compound was prepared in an analogous fashion to that described in Example 151 using 5-bromo-N-(4-(chlorodifluoromethoxy)phenyl)-6-((2-hydroxyethyl)(methyl)amino)nicotinamide (Stage 179.1) and 5-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)nicotinonitrile to afford a yellow solid. UPLC-MS (Condition 3)  $t_R$ =1.05 min,  $m/z$ =474.3  $[M+H]^+$ ,  $m/z$ =472.3  $[M-H]^-$ ;  $^1H$ -NMR (400 MHz, DMSO- $d_6$ )  $\delta$  ppm 2.70 (s, 3H) 3.48 (d, J=5.38 Hz, 2H) 3.56 (d, J=5.38 Hz, 2H) 4.66 (br. s, 1H) 7.36 (d, J=9.05 Hz,

## 212

2H) 7.81-7.93 (m, 2H) 8.15 (d, J=2.45 Hz, 1H) 8.46 (t, J=2.08 Hz, 1H) 8.77 (d, J=2.20 Hz, 1H) 9.01 (dd, J=7.21, 2.08 Hz, 2H) 10.23 (s, 1H).

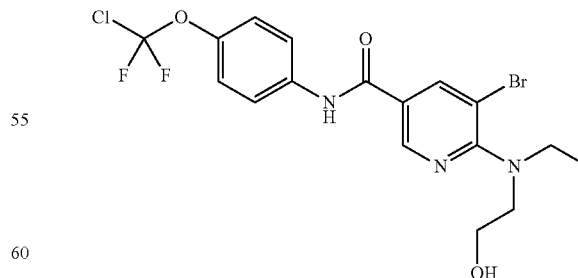
## Example 182

N-(4-(Chlorodifluoromethoxy)phenyl)-6-(ethyl(2-hydroxyethyl)amino)-5-(pyrimidin-5-yl)nicotinamide



The title compound was prepared in an analogous fashion to that described in Example 169 using 5-bromo-N-(4-(chlorodifluoromethoxy)phenyl)-6-(ethyl(2-hydroxyethyl)amino)nicotinamide (Stage 182.1) and pyrimidin-5-ylboronic acid to afford a light yellow foam. HPLC (Condition 4)  $t_R$ =5.23 min, UPLC-MS (Condition 3)  $t_R$ =1.01 min,  $m/z$ =464.3  $[M+H]^+$ ;  $^1H$ -NMR (400 MHz, DMSO- $d_6$ )  $\delta$  ppm 0.87 (t, J=6.84 Hz, 3H) 3.14 (m, J=7.00 Hz, 2H) 3.32-3.54 (m, 4H) 4.61 (t, J=5.28 Hz, 1H) 7.34 (d, J=8.21 Hz, 2H) 7.84 (d, J=1.00 Hz, 2H) 8.10 (dd, J=2.35, 1.17 Hz, 1H) 8.77 (dd, J=2.35, 1.17 Hz, 1H) 9.01 (d, J=0.78 Hz, 2H) 9.19 (d, J=1.17 Hz, 1H) 10.26 (s, 1H).

Stage 182.1 5-Bromo-N-(4-(chlorodifluoromethoxy)phenyl)-6-(ethyl(2-hydroxyethyl)amino)nicotinamide



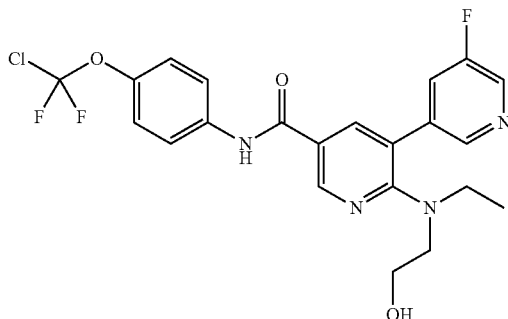
The title compound was prepared in an analogous fashion to that described in Stage 33.1 using 5-bromo-6-chloro-N-(4-(chlorodifluoromethoxy)phenyl)nicotinamide (Stage 169.2) and 2-ethylamino-ethanol to afford an off-white crystalline

## 213

solid. (Reaction Time was 10 h). HPLC (Condition 4)  $t_R$ =6.1 min, UPLC-MS (Condition 3)  $t_R$ =1.21 min,  $m/z$ =466.2  $[M+H]^+$ .

## Example 183

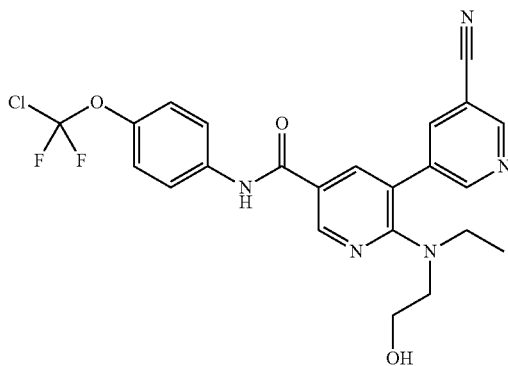
N-(4-(Chlorodifluoromethoxy)phenyl)-2-(ethyl(2-hydroxyethyl)amino)-5'-fluoro-[3,3'-bipyridine]-5-carboxamide



The title compound was prepared in an analogous fashion to that described in Example 169 using 5-bromo-N-(4-(chlorodifluoromethoxy)phenyl)-6-(ethyl(2-hydroxyethyl)amino)nicotinamide (Stage 182.1) and 3-fluoro-5-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)pyridine to afford an off-white foam. HPLC (Condition 4)  $t_R$ =5.71 min, UPLC-MS (Condition 3)  $t_R$ =1.11 min,  $m/z$ =481.3  $[M+H]^+$ ;  $^1H$ -NMR (400 MHz, DMSO- $d_6$ )  $\delta$  ppm 0.88 (t,  $J$ =6.84 Hz, 3H) 3.15 (m,  $J$ =7.00 Hz, 2H) 3.32-3.41 (m, 2H) 3.42-3.52 (m, 2H) 4.61 (t,  $J$ =5.08 Hz, 1H) 7.33 (d,  $J$ =8.60 Hz, 2H) 7.83 (d,  $J$ =0.78 Hz, 2H) 7.95 (d,  $J$ =1.17 Hz, 1H) 8.06 (d,  $J$ =1.00 Hz, 1H) 8.52-8.66 (m, 2H) 8.75 (d,  $J$ =2.74 Hz, 1H) 10.25 (s, 1H).

## Example 184

N-(4-(Chlorodifluoromethoxy)phenyl)-5'-cyano-2-(ethyl(2-hydroxyethyl)amino)-[3,3'-bipyridine]-5-carboxamide



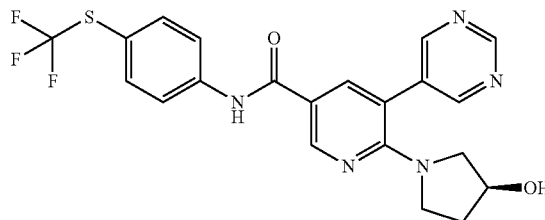
The title compound was prepared in an analogous fashion to that described in Example 151 using 5-bromo-N-(4-(chlorodifluoromethoxy)phenyl)-6-(ethyl(2-hydroxyethyl)amino)nicotinamide (Stage 182.1) and 5-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)nicotinonitrile to afford a

## 214

yellow solid. UPLC-MS (Condition 3)  $t_R$ =1.10 min,  $m/z$ =486.3  $[M+H]^+$ ,  $m/z$ =488.3  $[M-H]^-$ ;  $^1H$ -NMR (400 MHz, DMSO- $d_6$ )  $\delta$  ppm 0.90 (t,  $J$ =6.97 Hz, 3H) 3.15 (q,  $J$ =7.09 Hz, 2H) 3.37 (t,  $J$ =5.99 Hz, 2H) 3.44-3.55 (m, 2H) 4.62 (br. s, 1H) 7.36 (d,  $J$ =9.29 Hz, 2H) 7.82-7.90 (m, 2H) 8.11 (d,  $J$ =2.45 Hz, 1H) 8.54 (t,  $J$ =2.08 Hz, 1H) 8.79 (d,  $J$ =2.45 Hz, 1H) 9.04 (dd,  $J$ =5.62, 1.96 Hz, 2H) 10.26 (s, 1H).

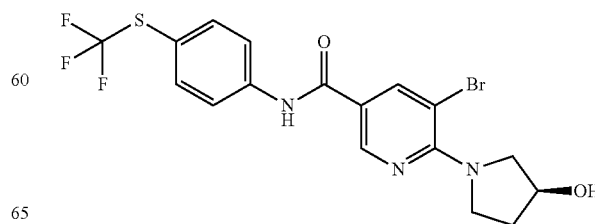
## Example 185

(S)-6-(3-Hydroxypyrrolidin-1-yl)-5-(pyrimidin-5-yl)-N-(4-((trifluoromethyl)thio)phenyl)nicotinamide



(S)-5-Bromo-6-(3-hydroxypyrrolidin-1-yl)-N-(4-((trifluoromethyl)thio)phenyl)nicotinamide (Stage 185.1, 116 mg, 0.25 mmol) and pyrimidin-5-ylboronic acid (62 mg, 0.5 mmol) were dissolved in DME (1 mL). A solution of 2 M  $NaHCO_3$  (0.375 mL, 0.75 mmol) was added, the mixture was flushed with argon, heated to 100° C. in a pressure safe vial and  $PdCl_2(dppf)$  (9.15 mg, 0.013 mmol) was added. The RM was stirred under argon at 100° C. for 2 h. The RM was cooled to RT, diluted with EtOAc and washed with brine. The organic layer was dried over  $Na_2SO_4$ , filtered and concentrated under reduced pressure. The residue was purified by flash chromatography (RediSep® Silica gel column, EtOAc/EtOAc/MeOH 98:2), 50% to 100% (EtOAc/MeOH 98:2) and treated with Si-Thiol (80 mg) in MeOH to afford the title compound as a white powder. HPLC (Condition 4)  $t_R$ =5.03 min, HPLC Chiral (CHIRALPAK® AD-H, 250×4.6 mm, 5  $\mu$ m, eluent: EtOH/MeOH (50:50), 1 mL/min, UV 220 nm,  $t_R$ =24.83 min, UPLC-MS (Condition 3)  $t_R$ =0.99 min,  $m/z$ =462.2  $[M+H]^+$ ;  $^1H$ -NMR (400 MHz, DMSO- $d_6$ )  $\delta$  ppm 1.67-1.78 (m, 1H) 1.80-1.90 (m, 1H) 2.88 (d,  $J$ =11.34 Hz, 1H) 3.21 (m,  $J$ =10.90, 4.70 Hz, 2H) 3.33-3.43 (m, 1H) 4.20 (d,  $J$ =1.96 Hz, 1H) 4.87 (d,  $J$ =3.52 Hz, 1H) 7.68 (d,  $J$ =8.60 Hz, 2H) 7.90 (d,  $J$ =8.99 Hz, 2H) 8.09 (d,  $J$ =2.35 Hz, 1H) 8.79 (d,  $J$ =2.35 Hz, 1H) 8.88 (s, 2H) 9.18 (s, 1H) 10.26 (s, 1H).

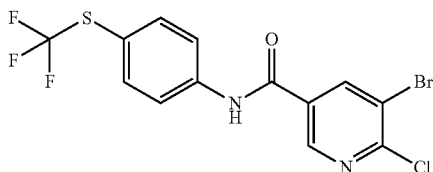
Stage 185.1 (S)-5-Bromo-6-(3-hydroxypyrrolidin-1-yl)-N-(4-((trifluoromethyl)thio)phenyl)nicotinamide



## 215

5-Bromo-6-chloro-N-(4-((trifluoromethyl)thio)phenyl)nicotinamide (Stage 185.2, 206 mg, 0.5 mmol) and (S)-pyrrolidin-3-ol (52.3 mg, 0.6 mmol) were dissolved in iPrOH (0.5 mL). DIPEA (192  $\mu$ L, 1.1 mmol) was added and the RM mixture was heated at 140° C. for 1 h in a pressure safe vial. The vial was cooled to RT and the RM was evaporated to dryness under reduced pressure to give residue that was purified by flash chromatography (RediSep® Silica gel column, n-heptane/EtOAc, from 20% to 100% EtOAc). Trituration with n-heptane, filtered and dried afforded the title compound as a white crystalline powder. HPLC (Condition 4)  $t_R$ =5.89 min, UPLC-MS (Condition 3)  $t_R$ =1.20 min,  $m/z$ =464.1 [M+H]<sup>+</sup>.

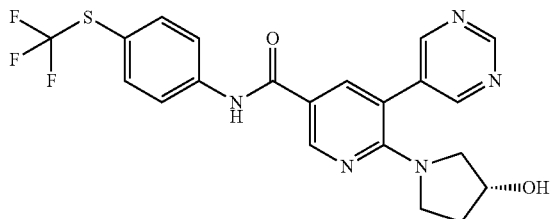
Stage 185.2 5-Bromo-6-chloro-N-(4-((trifluoromethyl)thio)phenyl)nicotinamide



DMF (0.12 mL) was added followed by slow addition of SOCl<sub>2</sub> (0.73 mL, 10 mmol) to a mixture of 5-bromo-6-chloro-nicotinic acid (473 mg, 2 mmol) in toluene (5 mL), and the RM was then stirred at 80° C. for 1 h. After cooling at RT, the toluene was evaporated off under reduced pressure and the residue was dissolved in THF (0.4 mL). DIPEA (0.7 mL, 4 mmol) was added and the solution was cooled to 0° C. under nitrogen. 4-trifluoromethylsulfanyl-aniline (438 mg, 2.2 mmol) in THF (1 mL) was then added dropwise and the RM was stirred at 0° C. for 2 h. The RM was diluted with TBME (50 mL), treated with 1 M HCl and extracted with TBME. The combined extracts were washed with 1 M aq. NaOH and brine, dried over Na<sub>2</sub>SO<sub>4</sub> and the solvent was evaporated off under reduced pressure and the product was crystallized from TBME/n-hexane to give the title compound as an off-white crystalline powder. HPLC (Condition 4)  $t_R$ =6.63 min, UPLC-MS (Condition 3)  $t_R$ =1.33 min,  $m/z$ =411.1 [M+H]<sup>+</sup>.

Example 186

(R)-6-(3-Hydroxypyrrolidin-1-yl)-5-(pyrimidin-5-yl)-N-(4-((trifluoromethyl)thio)phenyl)nicotinamide

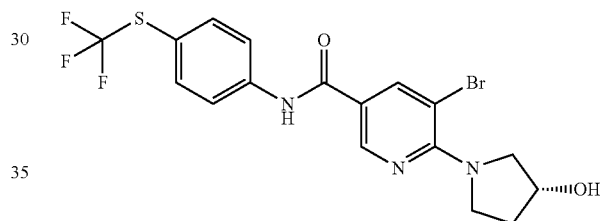


(R)-5-Bromo-6-(3-hydroxypyrrolidin-1-yl)-N-(4-((trifluoromethyl)thio)phenyl)nicotinamide (Stage 186.1, 92 mg,

## 216

0.2 mmol) and pyrimidin-5-ylboronic acid (49.6 mg, 0.4 mmol) were dissolved in DME (0.8 mL). A solution of 2 M Na<sub>2</sub>CO<sub>3</sub> (0.300 mL, 0.6 mmol) was added, the mixture was flushed with argon, heated to 100° C. in a pressure safe vial, then Pd(PPh<sub>3</sub>)<sub>2</sub>Cl<sub>2</sub> (14 mg, 0.02 mmol) was added. The RM was stirred under argon at 80-90° C. for 2 h. After cooling at RT, the RM was dissolved in EtOAc and washed with brine. The organic phase was dried over Na<sub>2</sub>SO<sub>4</sub> and the solvent was evaporated off under reduced pressure to give a residue that was purified by flash chromatography (RediSep® Silica gel column, (DCM/MeOH 98:2)/MeOH, from 0 to 5% MeOH) and treated with Si-Thiol (80 mg) in MeOH to afford the title compound as a beige crystalline powder. HPLC (Condition 4)  $t_R$ =5.02 min, HPLC Chiral (CHIRALPAK® AD-H, 250×4.6 mm, 5  $\mu$ m, eluent: EtOH/MeOH (50:50), 1 mL/min, UV 220 nm,  $t_R$ =10.32 min, UPLC-MS (Condition 3)  $t_R$ =1.00 min,  $m/z$ =462.2 [M+H]<sup>+</sup>; <sup>1</sup>H-NMR (400 MHz, DMSO-d<sub>6</sub>)  $\delta$  ppm 1.68-1.79 (m, 1H) 1.78-1.91 (m, 1H) 2.87 (d, J=1.00 Hz, 1H) 3.21 (m, J=6.60 Hz, 2H) 3.32-3.42 (m, 1H) 4.14-4.24 (m, 1H) 4.87 (d, J=3.13 Hz, 1H) 7.68 (d, J=8.60 Hz, 2H) 7.90 (d, J=8.60 Hz, 2H) 8.09 (d, J=1.95 Hz, 1H) 8.76-8.80 (m, 1H) 8.88 (s, 2H) 9.18 (s, 1H) 10.26 (s, 1H).

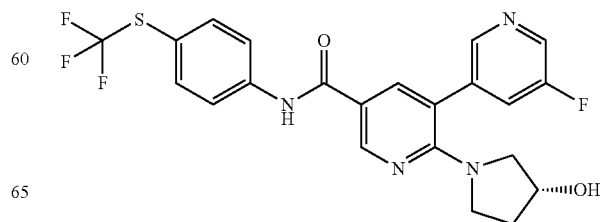
Stage 186.1 (R)-5-Bromo-6-(3-hydroxypyrrolidin-1-yl)-N-(4-((trifluoromethyl)thio)phenyl)nicotinamide



DIPEA (73  $\mu$ L, 0.42 mmol) was added to a solution of 5-bromo-6-chloro-N-(4-((trifluoromethyl)thio)phenyl)nicotinamide (Stage 185.2, 123 mg, 0.3 mmol) and (R)-pyrrolidin-3-ol (31.4 mg, 0.36 mmol) in iPrOH (300  $\mu$ L) in a vial, which was sealed and heated at 140° C. for 1 h. After cooling at RT, the RM was diluted with EtOAc, washed with brine, dried over Na<sub>2</sub>SO<sub>4</sub> and the solvent evaporated off under reduced pressure to give a residue which was triturated with iPr<sub>2</sub>O, filtered and dried to afford the title compound as a white crystalline powder. HPLC (Condition 4)  $t_R$ =5.9 min, UPLC-MS (Condition 3)  $t_R$ =1.21 min,  $m/z$ =464.1 [M+H]<sup>+</sup>.

Example 187

(R)-5'-Fluoro-2-(3-hydroxypyrrolidin-1-yl)-N-(4-((trifluoromethyl)thio)phenyl)-[3,3'-bipyridine]-5-carboxamide

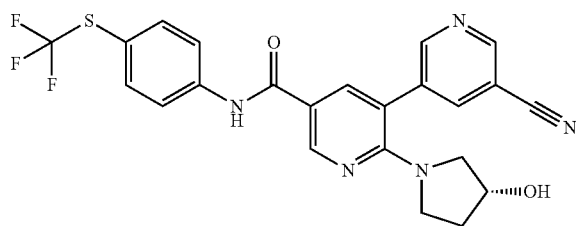


## 217

The title compound was prepared in an analogous fashion to that described in Example 151 using (R)-5-bromo-6-(3-hydroxypyrrolidin-1-yl)-N-(4-((trifluoromethyl)thio)phenyl)nicotinamide (Stage 186.1) and (5-fluoropyridin-3-yl)boronic acid to afford a yellow crystals. UPLC-MS (Condition 3)  $t_R=1.08$  min,  $m/z=479.4$   $[M+H]^+$ ,  $m/z=477.1$   $[M-H]^-$ ;  $^1H$ -NMR (400 MHz, DMSO- $d_6$ )  $\delta$  ppm 1.68-1.79 (m, 1H) 1.78-1.91 (m, 1H) 2.87 (d,  $J=11.29$  Hz, 1H) 3.15-3.30 (m, 2H) 3.35-3.46 (m, 1H) 4.16-4.24 (m, 1H) 4.89 (d,  $J=3.39$  Hz, 1H) 7.69 (d,  $J=8.66$  Hz, 2H) 7.84 (dt,  $J=9.72, 2.16$  Hz, 1H) 7.89-7.95 (m, 2H) 8.08 (d,  $J=2.38$  Hz, 1H) 8.51 (s, 1H) 8.60 (d,  $J=2.64$  Hz, 1H) 8.78 (d,  $J=2.26$  Hz, 1H) 10.29 (s, 1H).

## Example 188

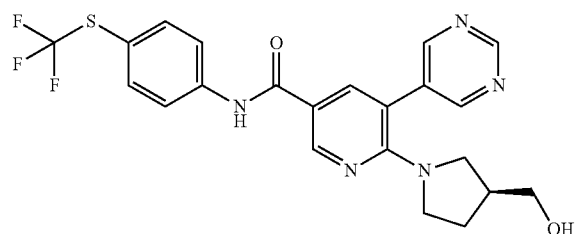
(R)-5'-Cyano-2-(3-hydroxypyrrolidin-1-yl)-N-(4-((trifluoromethyl)thio)phenyl)-[3,3'-bipyridine]-5-carboxamide



The title compound was prepared in an analogous fashion to that described in Example 151 using (R)-5-bromo-6-(3-hydroxypyrrolidin-1-yl)-N-(4-((trifluoromethyl)thio)phenyl)nicotinamide (Stage 186.1) and 5-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)nicotinonitrile to afford a beige solid. UPLC-MS (Condition 3)  $t_R=1.06$  min,  $m/z=486.1$   $[M+H]^+$ ,  $m/z=484.4$   $[M-H]^-$ ;  $^1H$ -NMR (400 MHz, DMSO- $d_6$ )  $\delta$  ppm 1.69-1.79 (m, 1H) 1.80-1.92 (m, 1H) 2.85 (d,  $J=11.29$  Hz, 1H) 3.16-3.27 (m, 2H) 3.35-3.43 (m, 1H) 4.18-4.25 (m, 1H) 4.90 (d,  $J=3.64$  Hz, 1H) 7.70 (d,  $J=8.78$  Hz, 2H) 7.88-7.96 (m, 2H) 8.10 (d,  $J=2.38$  Hz, 1H) 8.41 (t,  $J=2.07$  Hz, 1H) 8.80 (d,  $J=2.38$  Hz, 1H) 8.91 (d,  $J=2.13$  Hz, 1H) 9.03 (d,  $J=1.88$  Hz, 1H) 10.29 (s, 1H).

## Example 189

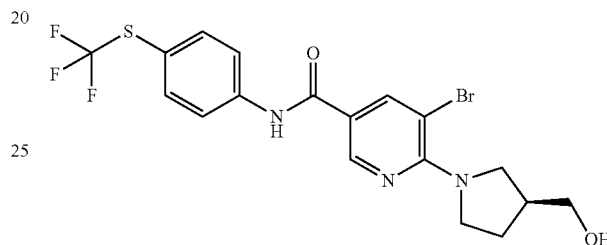
(S)-6-(3-(Hydroxymethyl)pyrrolidin-1-yl)-5-(pyrimidin-5-yl)-N-(4-((trifluoromethyl)thio)phenyl)nicotinamide



## 218

The title compound was prepared in an analogous fashion to that described in Example 185 using (S)-5-bromo-6-(3-(hydroxymethyl)pyrrolidin-1-yl)-N-(4-((trifluoromethyl)thio)phenyl)nicotinamide (Stage 189.1) and pyrimidin-5-ylboronic acid. HPLC (Condition 4)  $t_R=5.13$  min, UPLC-MS (Condition 3)  $t_R=1.01$  min,  $m/z=476.3$   $[M+H]^+$ ;  $^1H$ -NMR (400 MHz, DMSO- $d_6$ )  $\delta$  ppm 1.48-1.64 (m, 1H) 1.84 (m,  $J=6.30$  Hz, 1H) 2.15-2.31 (m, 1H) 2.96 (dd,  $J=10.95, 7.04$  Hz, 1H) 3.08-3.42 (m, 5H) 4.60 (t,  $J=5.28$  Hz, 1H) 7.68 (d,  $J=8.60$  Hz, 2H) 7.90 (d,  $J=8.99$  Hz, 2H) 8.08 (d,  $J=2.35$  Hz, 1H) 8.78 (d,  $J=2.35$  Hz, 1H) 8.88 (s, 2H) 9.17 (s, 1H) 10.25 (s, 1H).

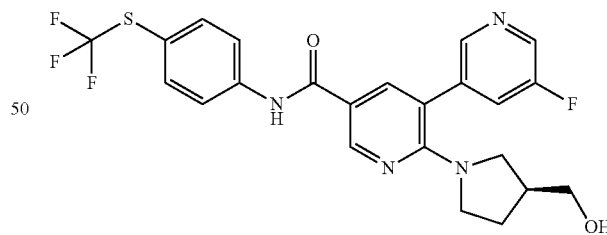
Stage 189.1 (S)-5-Bromo-6-(3-(hydroxymethyl)pyrrolidin-1-yl)-N-(4-((trifluoromethyl)thio)phenyl)nicotinamide



The title compound was prepared in an analogous fashion to that described in Stage 186.1 using 5-bromo-6-chloro-N-(4-((trifluoromethyl)thio)phenyl)nicotinamide (Stage 185.2) and (S)-1-pyrrolidin-3-yl-methanol. HPLC (Condition 4)  $t_R=6.17$  min, UPLC-MS (Condition 3)  $t_R=1.20$  min,  $m/z=476.2/478.2$   $[M+H]^+$ .

## Example 190

(S)-5'-Fluoro-2-(3-(hydroxymethyl)pyrrolidin-1-yl)-N-(4-((trifluoromethyl)thio)phenyl)-[3,3'-bipyridine]-5-carboxamide



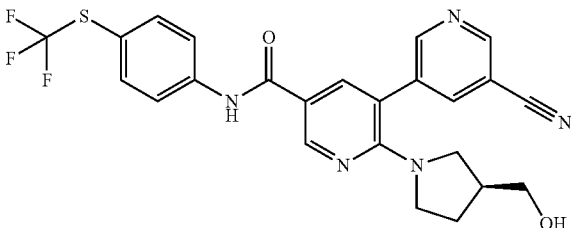
The title compound was prepared in an analogous fashion to that described in Example 185 using (S)-5-bromo-6-(3-(hydroxymethyl)pyrrolidin-1-yl)-N-(4-((trifluoromethyl)thio)phenyl)nicotinamide (Stage 189.1) and 3-fluoro-5-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)pyridine. HPLC (Condition 4)  $t_R=5.49$  min, UPLC-MS (Condition 3)  $t_R=1.10$  min,  $m/z=493.3$   $[M+H]^+$ ;  $^1H$ -NMR (400 MHz, DMSO- $d_6$ )  $\delta$  ppm 1.45-1.64 (m, 1H) 1.76-1.92 (m, 1H) 2.14-2.28 (m, 1H) 2.88-3.02 (m, 1H) 3.11-3.40 (m, 5H) 4.60 (t,  $J=1.00$  Hz, 1H) 7.67 (d,  $J=8.60$  Hz, 2H) 7.79-7.85 (m, 1H) 7.90 (d,  $J=8.60$  Hz,

## 219

2H) 8.06 (d, J=1.96 Hz, 1H) 8.50 (s, 1H) 8.57 (d, J=2.74 Hz, 1H) 8.77 (d, J=2.35 Hz, 1H) 10.26 (s, 1H).

## Example 191

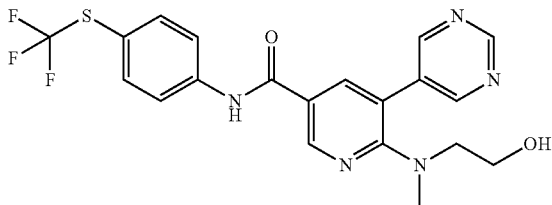
(S)-5'-Cyano-2-(3-(hydroxymethyl)pyrrolidin-1-yl)-N-(4-((trifluoromethyl)thio)phenyl)-[3,3'-bipyridine]-5-carboxamide



The title compound was prepared in an analogous fashion to that described in Example 151 using (S)-5-bromo-6-(3-(hydroxymethyl)pyrrolidin-1-yl)-N-(4-((trifluoromethyl)thio)phenyl)nicotinamide (Stage 189.1) and 5-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)nicotinonitrile to afford a yellow solid. UPLC-MS (Condition 3)  $t_R$ =1.09 min,  $m/z$ =500.3 [M+H]<sup>+</sup>,  $m/z$ =498.3 [M-H]<sup>-</sup>; <sup>1</sup>H-NMR (400 MHz, DMSO-d<sub>6</sub>)  $\delta$  ppm 1.49-1.69 (m, 1H) 1.77-1.96 (m, 1H) 2.16-2.30 (m, 1H) 2.97 (dd, J=11.00, 7.09 Hz, 1H) 3.10-3.22 (m, 2H) 3.22-3.27 (m, 1H) 3.34-3.45 (m, 2H) 4.60 (br. s, 1H) 7.70 (d, J=8.80 Hz, 2H) 7.87-7.99 (m, 2H) 8.09 (d, J=2.45 Hz, 1H) 8.41 (t, J=2.08 Hz, 1H) 8.80 (d, J=2.45 Hz, 1H) 8.91 (d, J=2.20 Hz, 1H) 9.02 (d, J=1.96 Hz, 1H) 10.27 (s, 1H).

## Example 192

6-((2-Hydroxyethyl)(methyl)amino)-5-(pyrimidin-5-yl)-N-(4-((trifluoromethyl)thio)phenyl)nicotinamide

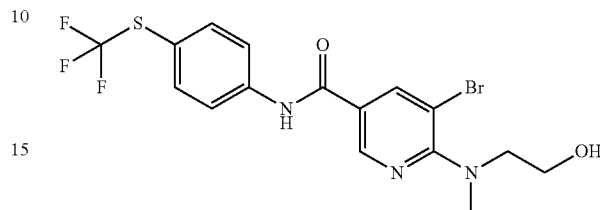


The title compound was prepared in an analogous fashion to that described in Example 185 using 5-bromo-6-((2-hydroxyethyl)(methyl)amino)-N-(4-((trifluoromethyl)thio)phenyl)nicotinamide (Stage 192.1) and pyrimidin-5-ylboronic acid to afford an off-white solid. HPLC (Condition 4)  $t_R$ =5.26 min, UPLC-MS (Condition 3)  $t_R$ =1.00 min,  $m/z$ =450.3 [M+H]<sup>+</sup>; <sup>1</sup>H-NMR (400 MHz, DMSO-d<sub>6</sub>)  $\delta$  ppm 2.69 (s, 3H) 3.40-3.62 (m, 4H) 4.67 (t, J=1.00 Hz, 1H) 7.69 (d,

## 220

J=8.60 Hz, 2H) 7.90 (d, J=1.00 Hz, 2H) 8.14 (d, J=2.30 Hz, 1H) 8.76 (d, J=2.50 Hz, 1H) 8.95 (s, 2H) 9.17 (s, 1H) 10.32 (s, 1H).

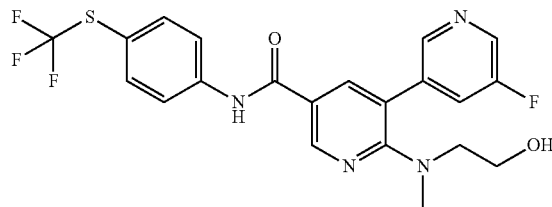
## 5 Stage 192.1 5-Bromo-6-((2-hydroxyethyl)(methyl)amino)-N-(4-((trifluoromethyl)thio)phenyl)nicotinamide



The title compound was prepared in an analogous fashion to that described in Stage 33.1 using 5-bromo-6-chloro-N-(4-((trifluoromethyl)thio)phenyl)nicotinamide (Stage 185.2) and 2-methylamino-ethanol to afford an off-white crystalline solid. HPLC (Condition 4)  $t_R$ =5.97 min, UPLC-MS (Condition 3)  $t_R$ =1.18 min,  $m/z$ =450.2 [M+H]<sup>+</sup>.

## Example 193

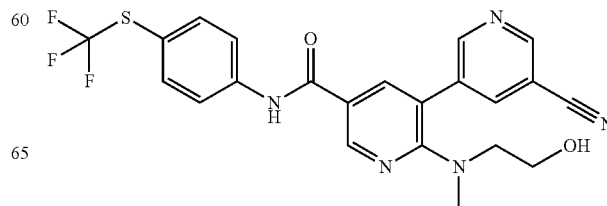
5'-Fluoro-2-((2-hydroxyethyl)(methyl)amino)-N-(4-((trifluoromethyl)thio)phenyl)-[3,3'-bipyridine]-5-carboxamide



The title compound was prepared in an analogous fashion to that described in Example 185 using 5-bromo-6-((2-hydroxyethyl)(methyl)amino)-N-(4-((trifluoromethyl)thio)phenyl)nicotinamide (Stage 192.1) and 3-fluoro-5-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)pyridine to afford an off-white foam. HPLC (Condition 4)  $t_R$ =5.7 min, UPLC-MS (Condition 3)  $t_R$ =1.10 min,  $m/z$ =467.3 [M+H]<sup>+</sup>; <sup>1</sup>H-NMR (400 MHz, DMSO-d<sub>6</sub>)  $\delta$  ppm 2.69 (s, 3H) 3.41-3.63 (m, 4H) 4.66 (t, J=5.28 Hz, 1H) 7.68 (d, J=8.99 Hz, 2H) 7.82-7.97 (m, 3H) 8.11 (d, J=2.35 Hz, 1H) 8.49-8.63 (m, 2H) 8.74 (d, J=2.35 Hz, 1H) 10.31 (s, 1H).

## Example 194

5'-Cyano-2-((2-hydroxyethyl)(methyl)amino)-N-(4-((trifluoromethyl)thio)phenyl)-[3,3'-bipyridine]-5-carboxamide

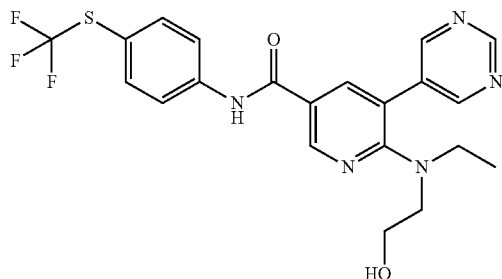


## 221

The title compound was prepared in an analogous fashion to that described in Example 151 using 5-bromo-6-((2-hydroxyethyl)(methyl)amino)-N-(4-((trifluoromethyl)thio)phenyl)nicotinamide (Stage 192.1) and 5-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)nicotinonitrile to afford a yellow solid. UPLC-MS (Condition 3)  $t_R$ =1.09 min,  $m/z$ =474.3  $[M+H]^+$ ,  $m/z$ =472.3  $[M-H]^-$ ;  $^1H$ -NMR (400 MHz, DMSO- $d_6$ )  $\delta$  ppm 2.70 (s, 3H) 3.42-3.52 (m, 2H) 3.52-3.62 (m, 2H) 4.68 (br. s, 1H) 7.70 (d,  $J$ =8.56 Hz, 2H) 7.88-7.98 (m, 2H) 8.14 (d,  $J$ =2.45 Hz, 1H) 8.45 (t,  $J$ =2.08 Hz, 1H) 8.77 (d,  $J$ =2.20 Hz, 1H) 9.00 (dd,  $J$ =8.44, 2.08 Hz, 2H) 10.32 (s, 1H).

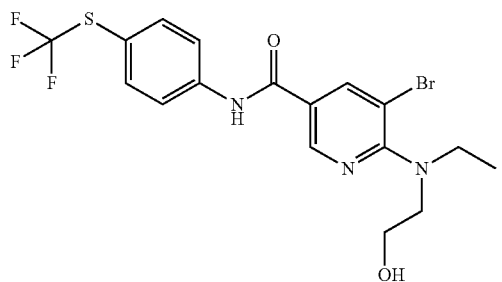
## Example 195

6-(Ethyl(2-hydroxyethyl)amino)-5-(pyrimidin-5-yl)-N-(4-((trifluoromethyl)thio)phenyl)nicotinamide



The title compound was prepared in an analogous fashion to that described in Example 185 using 5-bromo-6-(ethyl(2-hydroxyethyl)amino)-N-(4-((trifluoromethyl)thio)phenyl)nicotinamide (Stage 195.1) and pyrimidin-5-ylboronic acid to afford an off-white foam. HPLC (Condition 4)  $t_R$ =5.43 min, UPLC-MS (Condition 3)  $t_R$ =1.05 min,  $m/z$ =464.3  $[M+H]^+$ ;  $^1H$ -NMR (400 MHz, DMSO- $d_6$ )  $\delta$  ppm 0.88 (t,  $J$ =6.84 Hz, 3H) 3.14 (m,  $J$ =7.00, 7.00, 7.00 Hz, 2H) 3.32-3.52 (m, 4H) 4.61 (t,  $J$ =5.08 Hz, 1H) 7.69 (d,  $J$ =8.60 Hz, 2H) 7.90 (d,  $J$ =8.60 Hz, 2H) 8.10 (d,  $J$ =2.35 Hz, 1H) 8.77 (d,  $J$ =1.95 Hz, 1H) 9.01 (s, 2H) 9.19 (s, 1H) 10.35 (s, 1H).

Stage 195.1 5-Bromo-6-(ethyl(2-hydroxyethyl)amino)-N-(4-((trifluoromethyl)thio)phenyl)nicotinamide



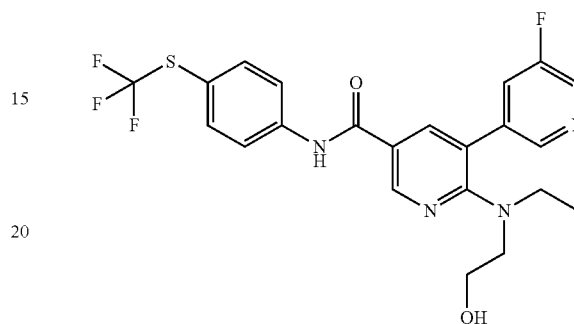
The title compound was prepared in an analogous fashion to that described in Stage 33.1 using 5-bromo-6-chloro-N-(4-((trifluoromethyl)thio)phenyl)nicotinamide (Stage 185.2) and 2-ethylamino-ethanol to afford a white crystalline solid.

## 222

(Reaction Time was 10 h). HPLC (Condition 4)  $t_R$ =6.33 min, UPLC-MS (Condition 3)  $t_R$ =1.25 min,  $m/z$ =466.2  $[M+H]^+$ .

## Example 196

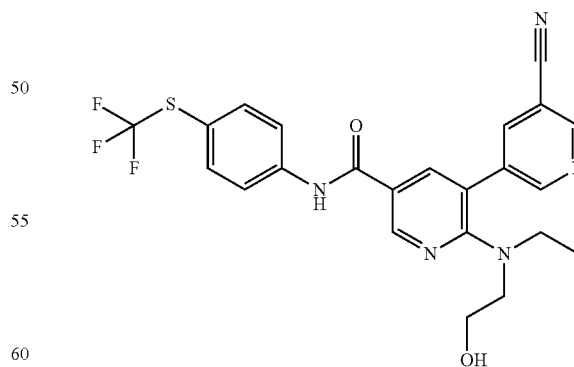
2-(Ethyl(2-hydroxyethyl)amino)-5'-fluoro-N-(4-((trifluoromethyl)thio)phenyl)-[3,3'-bipyridine]-5-carboxamide



The title compound was prepared in an analogous fashion to that described in Example 185 using 5-bromo-6-(ethyl(2-hydroxyethyl)amino)-N-(4-((trifluoromethyl)thio)phenyl)nicotinamide (Stage 195.1) and 3-fluoro-5-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)pyridine to afford an off-white foam. HPLC (Condition 4)  $t_R$ =5.89 min, UPLC-MS (Condition 3)  $t_R$ =1.15 min,  $m/z$ =481.3  $[M+H]^+$ ;  $^1H$ -NMR (400 MHz, DMSO- $d_6$ )  $\delta$  ppm 0.89 (t,  $J$ =7.04 Hz, 3H) 3.15 (m,  $J$ =6.60 Hz, 2H) 3.32-3.41 (m, 2H) 3.47 (m,  $J$ =5.90 Hz, 2H) 4.61 (t,  $J$ =1.00 Hz, 1H) 7.68 (d,  $J$ =8.60 Hz, 2H) 7.86-8.00 (m, 3H) 8.07 (d,  $J$ =2.35 Hz, 1H) 8.54-8.67 (m, 2H) 8.75 (d,  $J$ =2.35 Hz, 1H) 10.34 (s, 1H).

## Example 197

5'-Cyano-2-(ethyl(2-hydroxyethyl)amino)-N-(4-((trifluoromethyl)thio)phenyl)-[3,3'-bipyridine]-5-carboxamide



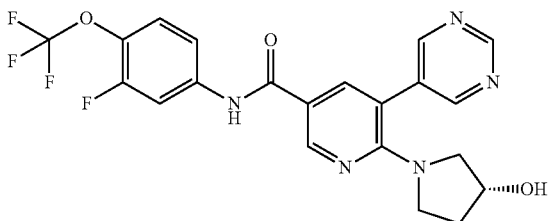
The title compound was prepared in an analogous fashion to that described in Example 151 using 5-bromo-6-(ethyl(2-hydroxyethyl)amino)-N-(4-((trifluoromethyl)thio)phenyl)nicotinamide (Stage 195.1) and 5-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)nicotinonitrile to afford a yellow resin.

## 223

UPLC-MS (Condition 3)  $t_R$ =1.13 min,  $m/z$ =488.3  $[M+H]^+$ ,  $m/z$ =486.3  $[M-H]^-$ ;  $^1H$ -NMR (400 MHz, DMSO- $d_6$ )  $\delta$  ppm 0.90 (t,  $J$ =6.97 Hz, 3H) 3.15 (q,  $J$ =6.93 Hz, 2H) 3.36-3.40 (m, 2H) 3.44-3.56 (m, 2H) 4.55 (br. s, 1H) 7.70 (d,  $J$ =8.56 Hz, 2H) 7.85-7.99 (m, 2H) 8.10 (d,  $J$ =2.45 Hz, 1H) 8.53 (t,  $J$ =2.08 Hz, 1H) 8.79 (d,  $J$ =2.20 Hz, 1H) 9.04 (dd,  $J$ =4.03, 2.08 Hz, 2H) 10.36 (s, 1H).

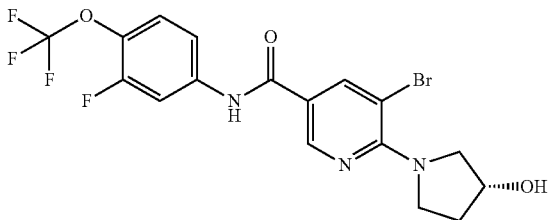
## Example 198

(R)—N-(3-Fluoro-4-(trifluoromethoxy)phenyl)-6-(3-hydroxypyrrolidin-1-yl)-5-(pyrimidin-5-yl)nicotinamide



The title compound was prepared in an analogous fashion to that described in Example 185 using (R)-5-bromo-N-(3-fluoro-4-(trifluoromethoxy)phenyl)-6-(3-hydroxypyrrolidin-1-yl)nicotinamide (Stage 198.1) and pyrimidin-5-ylboronic acid to afford a white powder. HPLC (Condition 4)  $t_R$ =4.88 min, UPLC-MS (Condition 3)  $t_R$ =0.96 min,  $m/z$ =464.2  $[M+H]^+$ ;  $^1H$ -NMR (400 MHz, DMSO- $d_6$ )  $\delta$  ppm 1.65-1.77 (m, 1H) 1.79-1.92 (m, 1H) 2.78-2.94 (m, 1H) 3.15-3.25 (m, 2H) 3.32-3.48 (m, 1H) 4.13-4.26 (m, 1H) 4.87 (d,  $J$ =3.52 Hz, 1H) 7.46-7.65 (m, 2H) 7.91-8.00 (m, 1H) 8.07 (d,  $J$ =2.35 Hz, 1H) 8.78 (d,  $J$ =2.35 Hz, 1H) 8.87 (s, 2H) 9.18 (s, 1H) 10.30 (s, 1H).

Stage 198.1 (R)-5-Bromo-N-(3-fluoro-4-(trifluoromethoxy)phenyl)-6-(3-hydroxypyrrolidin-1-yl)nicotinamide

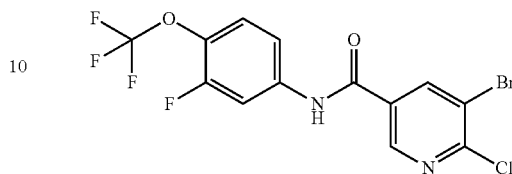


The title compound was prepared in an analogous fashion to that described in Stage 33.1 using 5-bromo-6-chloro-N-(3-fluoro-4-(trifluoromethoxy)phenyl)nicotinamide (Stage 198.2) and (R)-pyrrolidin-3-ol to afford an off-white crystal-

## 224

line solid. HPLC (Condition 4)  $t_R$ =5.82 min, UPLC-MS (Condition 3)  $t_R$ =1.17 min,  $m/z$ =464.1  $[M+H]^+$ .

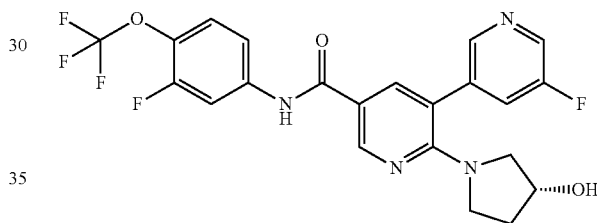
Stage 198.2 5-Bromo-6-chloro-N-(3-fluoro-4-(trifluoromethoxy)phenyl)nicotinamide



The title compound was prepared in an analogous fashion to that described in Stage 185.2 using 5-bromo-6-chloro-nicotinic acid and 3-fluoro-4-trifluoromethoxy-aniline to afford an off-white crystalline solid. HPLC (Condition 4)  $t_R$ =6.43 min, UPLC-MS (Condition 3)  $t_R$ =1.29 min,  $m/z$ =413  $[M-H]^-$ .

## Example 199

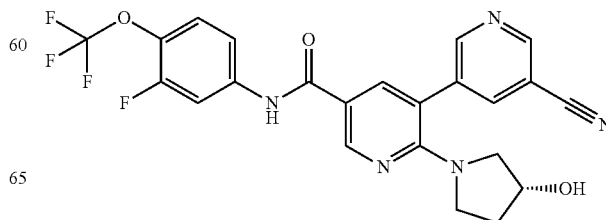
(R)-5'-Fluoro-N-(3-fluoro-4-(trifluoromethoxy)phenyl)-2-(3-hydroxypyrrolidin-1-yl)-[3,3'-bipyridine]-5-carboxamide



The title compound was prepared in an analogous fashion to that described in Example 151 using (R)-5-bromo-N-(3-fluoro-4-(trifluoromethoxy)phenyl)-6-(3-hydroxypyrrolidin-1-yl)nicotinamide (Stage 198.1) and (5-fluoropyridin-3-yl)boronic acid to afford a yellow wax. UPLC-MS (Condition 3)  $t_R$ =1.06 min,  $m/z$ =481.3  $[M+H]^+$ ,  $m/z$ =479.3  $[M-H]^-$ ;  $^1H$ -NMR (400 MHz, DMSO- $d_6$ )  $\delta$  ppm 1.70-1.80 (m, 1H) 1.80-1.91 (m, 1H) 2.89 (d,  $J$ =11.25 Hz, 1H) 3.19-3.29 (m, 2H) 3.35-3.46 (m, 1H) 4.21 (br. s, 1H) 4.86 (d,  $J$ =3.67 Hz, 1H) 7.55 (m,  $J$ =8.56 Hz, 1H) 7.61 (m,  $J$ =1.47 Hz, 1H) 7.83 (m,  $J$ =1.96 Hz, 1H) 7.98 (dd,  $J$ =13.20, 2.20 Hz, 1H) 8.07 (d,  $J$ =2.20 Hz, 1H) 8.51 (br. s, 1H) 8.60 (d,  $J$ =2.69 Hz, 1H) 8.78 (d,  $J$ =2.20 Hz, 1H) 10.30 (s, 1H).

## Example 200

(R)-5'-Cyano-N-(3-fluoro-4-(trifluoromethoxy)phenyl)-2-(3-hydroxypyrrolidin-1-yl)-[3,3'-bipyridine]-5-carboxamide

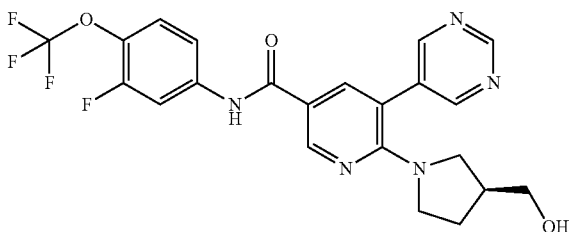


## 225

The title compound was prepared in an analogous fashion to that described in Example 151 using (R)-5-bromo-N-(3-fluoro-4-(trifluoromethoxy)phenyl)-6-(3-hydroxypyrrolidin-1-yl)nicotinamide (Stage 198.1) and 5-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)nicotinonitrile to afford a yellow solid. UPLC-MS (Condition 3)  $t_R$ =1.05 min,  $m/z$ =488.3  $[M+H]^+$ ,  $m/z$ =486.3  $[M-H]^-$ ;  $^1H$ -NMR (400 MHz, DMSO- $d_6$ )  $\delta$  ppm 1.75 (s, 1H) 1.81-1.92 (m, 1H) 2.87 (d,  $J$ =11.25 Hz, 1H) 3.15-3.27 (m, 2H) 3.33-3.44 (m, 1H) 4.21 (br. s, 1H) 4.87 (d,  $J$ =3.42 Hz, 1H) 7.51-7.64 (m, 2H) 7.98 (dd,  $J$ =13.20, 2.20 Hz, 1H) 8.08 (d,  $J$ =2.20 Hz, 1H) 8.40 (t,  $J$ =1.96 Hz, 1H) 8.79 (d,  $J$ =2.20 Hz, 1H) 8.90 (d,  $J$ =1.96 Hz, 1H) 9.03 (d,  $J$ =1.96 Hz, 1H) 10.31 (s, 1H).

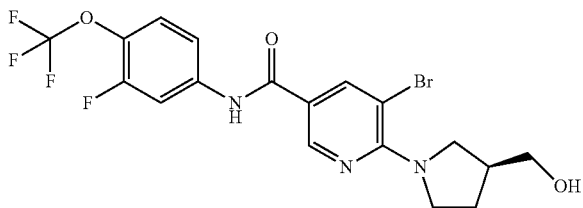
## Example 201

(S)-N-(3-Fluoro-4-(trifluoromethoxy)phenyl)-6-(3-(hydroxymethyl)pyrrolidin-1-yl)-5-(pyrimidin-5-yl)nicotinamide



The title compound was prepared in an analogous fashion to that described in Example 185 using (S)-5-bromo-N-(3-fluoro-4-(trifluoromethoxy)phenyl)-6-(3-(hydroxymethyl)pyrrolidin-1-yl)nicotinamide (Stage 201.1) and pyrimidin-5-ylboronic acid to afford a white powder. HPLC (Condition 4)  $t_R$ =4.98 min, UPLC-MS (Condition 3)  $t_R$ =0.97 min,  $m/z$ =478.2  $[M+H]^+$ ;  $^1H$ -NMR (400 MHz, DMSO- $d_6$ )  $\delta$  ppm 1.50-1.65 (m, 1H) 1.84 (m,  $J$ =6.60 Hz, 1H) 2.15-2.29 (m, 1H) 2.96 (dd,  $J$ =10.75, 6.84 Hz, 1H) 3.06-3.42 (m, 5H) 4.60 (t,  $J$ =5.28 Hz, 1H) 7.47-7.64 (m, 2H) 7.96 (dd,  $J$ =13.10, 2.15 Hz, 1H) 8.06 (d,  $J$ =2.35 Hz, 1H) 8.77 (d,  $J$ =2.74 Hz, 1H) 8.84-8.94 (m, 2H) 9.17 (s, 1H) 10.29 (s, 1H).

Stage 201.1 (S)-5-Bromo-N-(3-fluoro-4-(trifluoromethoxy)phenyl)-6-(3-(hydroxymethyl)pyrrolidin-1-yl)nicotinamide



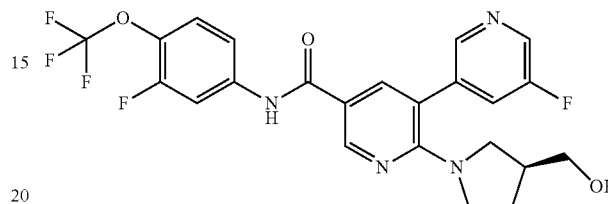
The title compound was prepared in an analogous fashion to that described in Stage 33.1 using 5-bromo-6-chloro-N-(3-fluoro-4-(trifluoromethoxy)phenyl)nicotinamide (Stage 198.2) and (S)-1-pyrrolidin-3-yl-methanol to afford an off-

## 226

white crystalline solid. HPLC (Condition 4)  $t_R$ =5.99 min, UPLC-MS (Condition 3)  $t_R$ =1.18 min,  $m/z$ =478.1/480.1  $[M+H]^+$ .

## Example 202

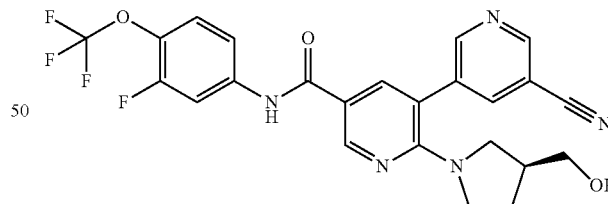
(S)-5'-Fluoro-N-(3-fluoro-4-(trifluoromethoxy)phenyl)-2-(3-(hydroxymethyl)pyrrolidin-1-yl)-[3,3'-bipyridine]-5-carboxamide



The title compound was prepared in an analogous fashion to that described in Example 185 using (S)-5-bromo-N-(3-fluoro-4-(trifluoromethoxy)phenyl)-6-(3-(hydroxymethyl)pyrrolidin-1-yl)nicotinamide (Stage 201.1) and 3-fluoro-5-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)pyridine to afford a white powder. HPLC (Condition 4)  $t_R$ =5.4 min, UPLC-MS (Condition 3)  $t_R$ =1.07 min,  $m/z$ =495.3  $[M+H]^+$ ;  $^1H$ -NMR (400 MHz, DMSO- $d_6$ )  $\delta$  ppm 1.46-1.64 (m, 1H) 1.73-1.92 (m, 1H) 2.11-2.27 (m, 1H) 2.85-3.03 (m, 1H) 3.11-3.39 (m, 5H) 4.60 (t,  $J$ =1.00 Hz, 1H) 7.41-7.64 (m, 2H) 7.74-7.87 (m, 1H) 7.91-8.00 (m, 1H) 8.04 (d,  $J$ =2.35 Hz, 1H) 8.50 (s, 1H) 8.58 (d,  $J$ =2.74 Hz, 1H) 8.76 (d,  $J$ =1.00 Hz, 1H) 10.29 (s, 1H).

## Example 203

(S)-5'-Cyano-N-(3-fluoro-4-(trifluoromethoxy)phenyl)-2-(3-(hydroxymethyl)pyrrolidin-1-yl)-[3,3'-bipyridine]-5-carboxamide



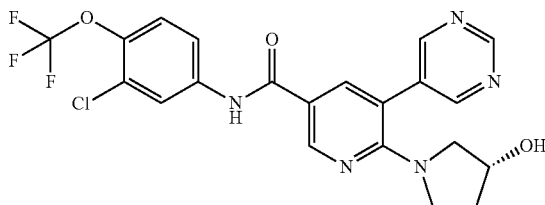
The title compound was prepared in an analogous fashion to that described in Example 151 using (S)-5-bromo-N-(3-fluoro-4-(trifluoromethoxy)phenyl)-6-(3-(hydroxymethyl)pyrrolidin-1-yl)nicotinamide (Stage 201.1) and 5-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)nicotinonitrile to afford a white powder. UPLC-MS (Condition 3)  $t_R$ =1.06 min,  $m/z$ =502.4  $[M+H]^+$ ,  $m/z$ =500.3  $[M-H]^-$ ;  $^1H$ -NMR (400 MHz, DMSO- $d_6$ )  $\delta$  ppm 1.51-1.66 (m, 1H) 1.79-1.92 (m, 1H) 2.16-2.30 (m, 1H) 2.96 (dd,  $J$ =11.00, 6.85 Hz, 1H) 3.10-3.28 (m, 4H) 3.32-3.41 (m, 1H) 4.60 (t,  $J$ =5.26 Hz, 1H) 7.50-7.65 (m, 2H) 7.98 (dd,  $J$ =13.08, 2.32 Hz, 1H) 8.07 (d,  $J$ =2.45 Hz,

## 227

<sup>1</sup>H) 8.40 (t, J=2.20 Hz, 1H) 8.79 (d, J=2.45 Hz, 1H) 8.90 (d, J=1.96 Hz, 1H) 9.02 (d, J=1.96 Hz, 1H) 10.30 (s, 1H).

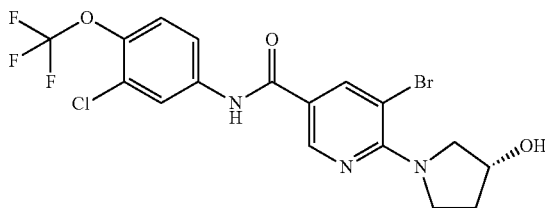
## Example 204

(R)—N-(3-Chloro-4-(trifluoromethoxy)phenyl)-6-(3-hydroxypyrrolidin-1-yl)-5-(pyrimidin-5-yl)nicotinamide



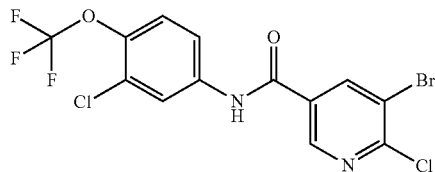
The title compound was prepared in an analogous fashion to that described in Example 185 using (R)-5-bromo-N-(3-chloro-4-(trifluoromethoxy)phenyl)-6-(3-hydroxypyrrolidin-1-yl)nicotinamide (Stage 204.1) and pyrimidin-5-ylboronic acid to afford a white foam. HPLC (Condition 4)  $t_R$ =5.17 min, UPLC-MS (Condition 3)  $t_R$ =1.03 min,  $m/z$ =480.1 [M+H]<sup>+</sup>; <sup>1</sup>H-NMR (400 MHz, DMSO-d<sub>6</sub>)  $\delta$  ppm 1.74 (m, J=3.90 Hz, 1H) 1.79-1.93 (m, 1H) 2.88 (d, J=11.34 Hz, 1H) 3.21 (m, J=11.10, 4.50 Hz, 2H) 3.37 (m, J=7.00 Hz, 1H) 4.11-4.25 (m, 1H) 4.87 (d, J=3.52 Hz, 1H) 7.55 (d, J=8.99 Hz, 1H) 7.72-7.86 (m, 1H) 8.10 (dd, J=15.84, 2.54 Hz, 2H) 8.74-8.81 (m, 1H) 8.88 (s, 2H) 9.19 (s, 1H) 10.27 (s, 1H).

Stage 204.1 (R)-5-Bromo-N-(3-chloro-4-(trifluoromethoxy)phenyl)-6-(3-hydroxypyrrolidin-1-yl)nicotinamide



The title compound was prepared in an analogous fashion to that described in Stage 33.1 using 5-bromo-6-chloro-N-(3-chloro-4-(trifluoromethoxy)phenyl)nicotinamide (Stage 204.2) and (R)-pyrrolidin-3-ol to afford an off-white crystalline solid. HPLC (Condition 4)  $t_R$ =6.05 min, UPLC-MS (Condition 3)  $t_R$ =1.24 min,  $m/z$ =480.1/482.1 [M+H]<sup>+</sup>.

Stage 204.2 5-Bromo-6-chloro-N-(3-chloro-4-(trifluoromethoxy)phenyl)nicotinamide

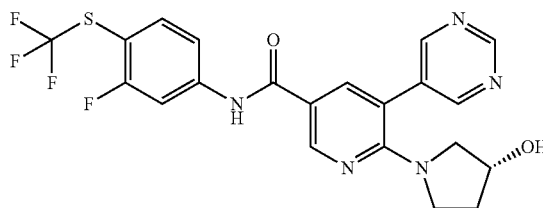


## 228

The title compound was prepared in an analogous fashion to that described in Stage 185.2 using 5-bromo-6-chloro-nicotinic acid and 3-chloro-4-(trifluoromethoxy)aniline to afford an off-white crystalline solid. HPLC (Condition 4)  $t_R$ =6.72 min, UPLC-MS (Condition 3)  $t_R$ =1.34 min,  $m/z$ =429.0 [M-H]<sup>-</sup>.

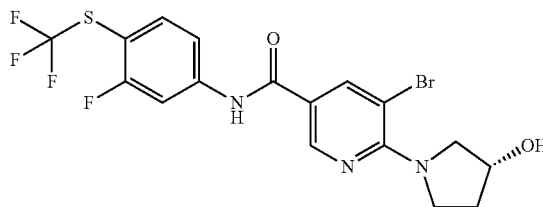
## Example 205

(R)—N-(3-Fluoro-4-((trifluoromethyl)thio)phenyl)-6-(3-hydroxypyrrolidin-1-yl)-5-(pyrimidin-5-yl)nicotinamide



The title compound was prepared in an analogous fashion to that described in Example 185 using (R)-5-bromo-N-(3-fluoro-4-((trifluoromethyl)thio)phenyl)-6-(3-hydroxypyrrolidin-1-yl)nicotinamide (Stage 205.1) and pyrimidin-5-ylboronic acid to afford a white powder. HPLC (Condition 4)  $t_R$ =5.22 min, UPLC-MS (Condition 3)  $t_R$ =1.03 min,  $m/z$ =480.2 [M+H]<sup>+</sup>; <sup>1</sup>H-NMR (400 MHz, DMSO-d<sub>6</sub>)  $\delta$  ppm 1.67-1.77 (m, 1H) 1.79-1.94 (m, 1H) 2.82-2.94 (m, 1H) 3.22 (m, J=11.10, 4.10 Hz, 2H) 3.32-3.45 (m, 1H) 4.14-4.29 (m, 1H) 4.87 (d, J=3.91 Hz, 1H) 7.58-7.80 (m, 2H) 7.96 (dd, J=11.73, 1.96 Hz, 1H) 8.08 (d, J=2.35 Hz, 1H) 8.79 (d, J=2.35 Hz, 1H) 8.88 (s, 2H) 9.18 (s, 1H) 10.43 (s, 1H).

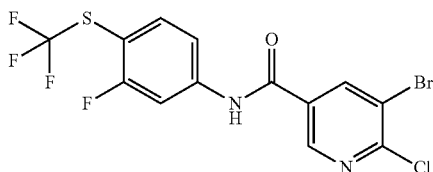
Stage 205.1 (R)-5-Bromo-N-(3-fluoro-4-((trifluoromethyl)thio)phenyl)-6-(3-hydroxypyrrolidin-1-yl)nicotinamide



The title compound was prepared in an analogous fashion to that described in Stage 33.1 using 5-bromo-6-chloro-N-(3-fluoro-4-((trifluoromethyl)thio)phenyl)nicotinamide (Stage 205.2) and (R)-pyrrolidin-3-ol to afford an off-white crystalline solid. HPLC (Condition 4)  $t_R$ =6.11 min, UPLC-MS (Condition 3)  $t_R$ =1.23 min,  $m/z$ =480.1 [M+H]<sup>+</sup>.

## 229

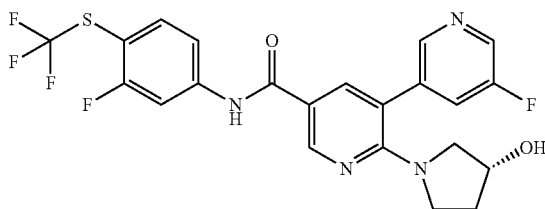
Stage 205.2 5-Bromo-6-chloro-N-(3-fluoro-4-((trifluoromethyl)thio)phenyl)nicotinamide



The title compound was prepared in an analogous fashion to that described in Stage 185.2 using 5-bromo-6-chloro-nicotinic acid and 3-fluoro-4-trifluoromethylsulfanyl-aniline to afford a white crystalline solid. HPLC (Condition 4)  $t_R$ =6.71 min, UPLC-MS (Condition 3)  $t_R$ =1.34 min,  $m/z$ =429  $[M-H]^-$ .

## Example 206

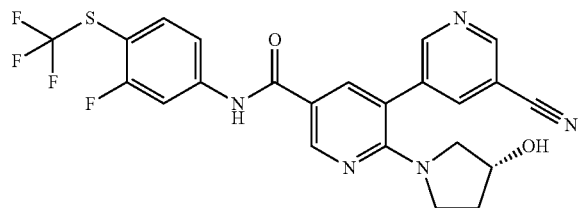
(R)-5'-Fluoro-N-(3-fluoro-4-((trifluoromethyl)thio)phenyl)-2-(3-hydroxypyrrolidin-1-yl)-[3,3'-bipyridine]-5-carboxamide



The title compound was prepared in an analogous fashion to that described in Example 151 using (R)-5-bromo-N-(3-fluoro-4-((trifluoromethyl)thio)phenyl)-6-(3-hydroxypyrrolidin-1-yl)nicotinamide (Stage 205.1) and (5-fluoropyridin-3-yl)boronic acid to afford a yellow wax which slowly crystallized upon drying. UPLC-MS (Condition 3)  $t_R$ =1.12 min,  $m/z$ =497.3  $[M+H]^+$ ,  $m/z$ =495.3  $[M-H]^-$ ;  $^1H$ -NMR (400 MHz, DMSO- $d_6$ )  $\delta$  ppm 1.67-1.79 (m, 1H) 1.84 (qd,  $J$ =8.43, 4.33 Hz, 1H) 2.88 (d,  $J$ =11.42 Hz, 1H) 3.18-3.29 (m, 2H) 3.34-3.47 (m, 1H) 4.14-4.27 (m, 1H) 4.88 (d,  $J$ =3.39 Hz, 1H) 7.67 (dd,  $J$ =8.66, 2.01 Hz, 1H) 7.75 (t,  $J$ =8.41 Hz, 1H) 7.84 (dt,  $J$ =9.72, 2.10 Hz, 1H) 7.97 (dd,  $J$ =11.73, 2.07 Hz, 1H) 8.07 (d,  $J$ =2.38 Hz, 1H) 8.48-8.54 (m, 1H) 8.60 (d,  $J$ =2.76 Hz, 1H) 8.79 (d,  $J$ =2.26 Hz, 1H) 10.45 (s, 1H).

## Example 207

(R)-5'-Cyano-N-(3-fluoro-4-((trifluoromethyl)thio)phenyl)-2-(3-hydroxypyrrolidin-1-yl)-[3,3'-bipyridine]-5-carboxamide

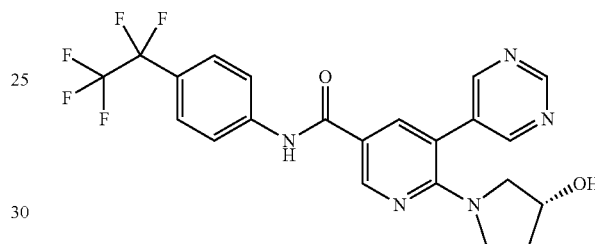


## 230

The title compound was prepared in an analogous fashion to that described in Example 151 using (R)-5-bromo-N-(3-fluoro-4-((trifluoromethyl)thio)phenyl)-6-(3-hydroxypyrrolidin-1-yl)nicotinamide (Stage 205.1) and 5-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)nicotinonitrile to afford a yellow solid. UPLC-MS (Condition 3)  $t_R$ =1.10 min,  $m/z$ =504.3  $[M+H]^+$ ,  $m/z$ =502.3  $[M-H]^-$ ;  $^1H$ -NMR (400 MHz, DMSO- $d_6$ )  $\delta$  ppm 1.67-1.78 (m, 1H) 1.83 (dd,  $J$ =8.72, 4.33 Hz, 1H) 2.84 (d,  $J$ =11.29 Hz, 1H) 3.13-3.25 (m, 2H) 3.34-3.41 (m, 1H) 4.14-4.24 (m, 1H) 4.87 (d,  $J$ =3.51 Hz, 1H) 7.65 (dd,  $J$ =8.91, 1.88 Hz, 1H) 7.74 (t,  $J$ =8.16 Hz, 1H) 7.95 (dd,  $J$ =11.80, 2.13 Hz, 1H) 8.07 (d,  $J$ =2.38 Hz, 1H) 8.38 (t,  $J$ =2.07 Hz, 1H) 8.78 (d,  $J$ =2.26 Hz, 1H) 8.88 (d,  $J$ =2.13 Hz, 1H) 9.01 (d,  $J$ =2.01 Hz, 1H) 10.43 (s, 1H).

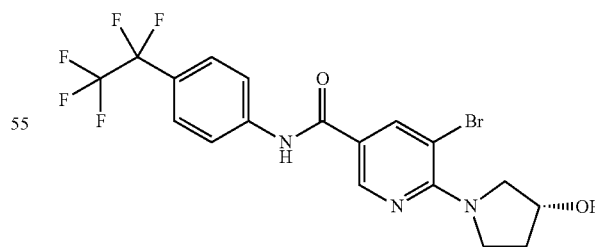
## Example 208

(R)-6-(3-Hydroxypyrrolidin-1-yl)-N-(4-(perfluoroethyl)phenyl)-5-(pyrimidin-5-yl)nicotinamide



The title compound was prepared in an analogous fashion to that described in Example 185 using (R)-5-bromo-6-(3-hydroxypyrrolidin-1-yl)-N-(4-(perfluoroethyl)phenyl)nicotinamide (Stage 208.1) and pyrimidin-5-ylboronic acid to afford a foam. HPLC (Condition 4)  $t_R$ =5.11 min, UPLC-MS (Condition 3)  $t_R$ =1.00 min,  $m/z$ =480.2  $[M+H]^+$ ;  $^1H$ -NMR (400 MHz, DMSO- $d_6$ )  $\delta$  ppm 1.68-1.79 (m, 1H) 1.85 (m,  $J$ =9.00 Hz, 1H) 2.88 (d,  $J$ =11.73 Hz, 1H) 3.14-3.27 (m, 2H) 3.38 (m,  $J$ =7.00 Hz, 1H) 4.20 (m,  $J$ =2.30 Hz, 1H) 4.87 (d,  $J$ =3.52 Hz, 1H) 7.66 (d,  $J$ =8.60 Hz, 2H) 7.99 (d,  $J$ =8.60 Hz, 2H) 8.10 (d,  $J$ =2.35 Hz, 1H) 8.80 (d,  $J$ =1.96 Hz, 1H) 8.88 (s, 2H) 9.18 (s, 1H) 10.31 (s, 1H).

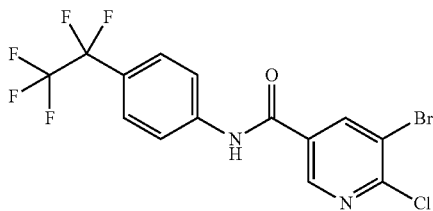
Stage 208.1 (R)-5-Bromo-6-(3-hydroxypyrrolidin-1-yl)-N-(4-(perfluoroethyl)phenyl)nicotinamide



The title compound was prepared in an analogous fashion to that described in Stage 33.1 using 5-bromo-6-chloro-N-(4-(perfluoroethyl)phenyl)nicotinamide (Stage 208.2) and (R)-pyrrolidin-3-ol to afford an off-white crystalline solid. HPLC (Condition 4)  $t_R$ =5.96 min, UPLC-MS (Condition 3)  $t_R$ =1.20 min,  $m/z$ =480.2  $[M+H]^+$ .

## 231

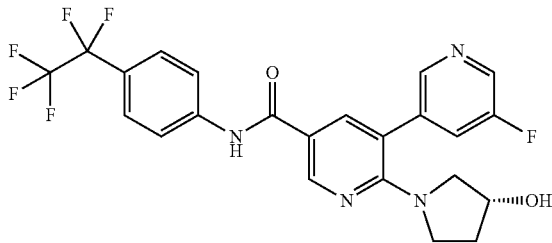
Stage 208.2 5-Bromo-6-chloro-N-(4-(perfluoroethyl)phenyl)nicotinamide



The title compound was prepared in an analogous fashion to that described in Stage 185.2 using 5-bromo-6-chloro-nicotinic acid and 4-pentafluoroethyl-aniline to afford a white crystalline solid. HPLC (Condition 4)  $t_R$ =6.61 min, UPLC-MS (Condition 3)  $t_R$ =1.32 min,  $m/z$ =429 [M-H]<sup>-</sup>.

## Example 209

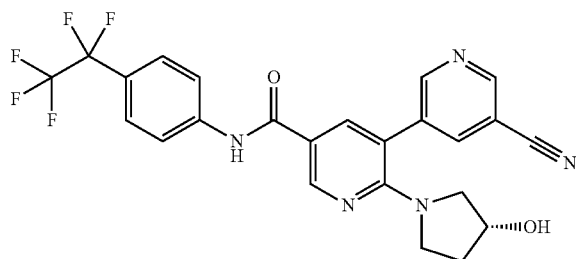
(R)-5'-Fluoro-2-(3-hydroxypyrrolidin-1-yl)-N-(4-(perfluoroethyl)phenyl)-[3,3'-bipyridine]-5-carboxamide



The title compound was prepared in an analogous fashion to that described in Example 151 using (R)-5-bromo-6-(3-hydroxypyrrolidin-1-yl)-N-(4-(perfluoroethyl)phenyl)nicotinamide (Stage 208.1) and (5-fluoropyridin-3-yl)boronic acid to afford a beige solid. UPLC-MS (Condition 3)  $t_R$ =1.10 min,  $m/z$ =497.4 [M+H]<sup>+</sup>,  $m/z$ =495.3 [M-H]<sup>-</sup>; <sup>1</sup>H-NMR (400 MHz, DMSO-d<sub>6</sub>) δ ppm 1.69-1.79 (m, 1H) 1.85 (m, J=9.05 Hz, 1H) 2.88 (d, J=11.25 Hz, 1H) 3.18-3.29 (m, 2H) 3.35-3.46 (m, 1H) 4.16-4.26 (m, 1H) 4.87 (d, J=3.42 Hz, 1H) 7.67 (d, J=8.80 Hz, 2H) 7.84 (dt, J=9.66, 2.26 Hz, 1H) 8.00 (d, J=8.80 Hz, 2H) 8.09 (d, J=2.20 Hz, 1H) 8.49-8.53 (m, 1H) 8.60 (d, J=2.93 Hz, 1H) 8.80 (d, J=2.20 Hz, 1H) 10.33 (s, 1H).

## Example 210

(R)-5'-Cyano-2-(3-hydroxypyrrolidin-1-yl)-N-(4-(perfluoroethyl)phenyl)-[3,3'-bipyridine]-5-carboxamide

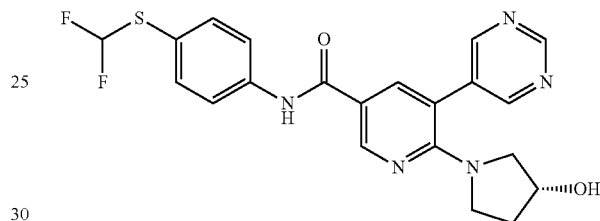


## 232

The title compound was prepared in an analogous fashion to that described in Example 151 using (R)-5-bromo-6-(3-hydroxypyrrolidin-1-yl)-N-(4-(perfluoroethyl)phenyl)nicotinamide (Stage 208.1) and 5-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)nicotinonitrile to afford a yellow solid. UPLC-MS (Condition 3)  $t_R$ =1.08 min,  $m/z$ =504.4 [M+H]<sup>+</sup>,  $m/z$ =502.3 [M-H]<sup>-</sup>; <sup>1</sup>H-NMR (400 MHz, DMSO-d<sub>6</sub>) δ ppm 1.69-1.80 (m, 1H) 1.80-1.92 (m, 1H) 2.86 (d, J=11.25 Hz, 1H) 3.16-3.28 (m, 2H) 3.39 (m, J=9.29 Hz, 1H) 4.21 (br. s, 1H) 4.89 (d, J=3.18 Hz, 1H) 7.67 (d, J=8.80 Hz, 2H) 8.01 (d, J=8.56 Hz, 2H) 8.11 (d, J=2.20 Hz, 1H) 8.38-8.43 (m, 1H) 8.81 (d, J=2.20 Hz, 1H) 8.91 (d, J=1.96 Hz, 1H) 9.03 (d, J=1.96 Hz, 1H) 10.34 (s, 1H).

## Example 211

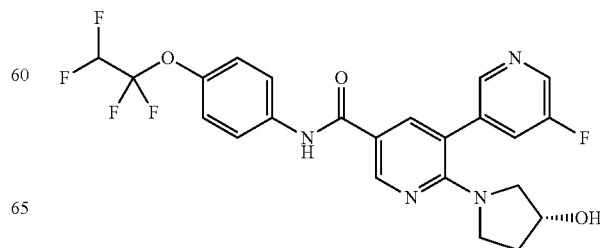
(R)-N-(4-((difluoromethyl)thio)phenyl)-6-(3-hydroxypyrrolidin-1-yl)-5-(pyrimidin-5-yl)nicotinamide



A mixture of (R)-6-(3-hydroxypyrrolidin-1-yl)-5-(pyrimidin-5-yl)nicotinic acid (Stage 170.1, 60 mg, 0.21 mmol), O-(7-azabenzotriazol-1-yl)-N,N,N',N'-tetramethyluronium hexafluorophosphate (HATU, 88 mg, 0.231 mmol) and DIPEA (73.2 μL, 0.419 mmol), in DMF (419 μL), was stirred at RT for 10 min. 4-Difluoromethylsulfanyl-aniline (60 mg, 0.21 mmol) was added and the RM was stirred for 2 days. The RM was diluted with EtOAc and washed with brine. The organic phase was dried over MgSO<sub>4</sub> and evaporated to dryness under reduced pressure. The crude product was purified by preparative SFC (Column 2-EP, from 20% to 25% in 6 min) to obtain the title compound as a solid. UPLC-MS (Condition 3),  $t_R$ =0.86 min,  $m/z$ =444.3 [M+H]<sup>+</sup>; <sup>1</sup>H-NMR (400 MHz, DMSO-d<sub>6</sub>) δ ppm (TFA), 1.82 (br. s, 1H) 1.90 (d, J=8.60 Hz, 1H) 2.97 (d, J=10.95 Hz, 1H) 3.28 (d, J=7.04 Hz, 2H) 3.35-3.47 (m, 1H) 4.26 (br. s, 1H) 7.49-7.63 (m, 2H) 7.79-7.90 (m, 2H) 8.25 (br. s, 1H) 8.74 (br. s, 1H) 8.89-8.98 (m, 2H) 9.20-9.28 (m, 1H).

## Example 212

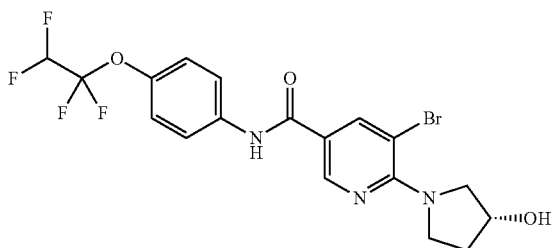
(R)-5'-Fluoro-2-(3-hydroxypyrrolidin-1-yl)-N-(4-(1,2,2-tetrafluoroethoxy)phenyl)-[3,3'-bipyridine]-5-carboxamide



## 233

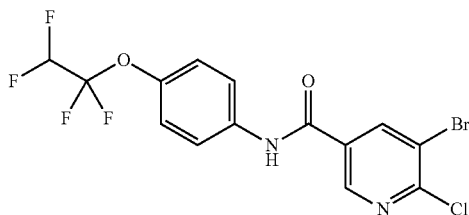
The title compound was prepared in an analogous fashion to that described in Example 151 using (R)-5-bromo-6-(3-hydroxypyrrolidin-1-yl)-N-(4-(1,1,2,2-tetrafluoroethoxy)phenyl)nicotinamide (Stage 212.1) and 3-fluoro-5-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)pyridine to afford a solid. UPLC-MS (Condition 3),  $t_R$ =0.96 min,  $m/z$ =495.3;  $^1\text{H-NMR}$  (400 MHz, DMSO- $d_6$ ),  $\delta$  ppm 1.75 (br. s, 1H) 1.86 (d,  $J$ =8.21 Hz, 1H) 2.88 (d,  $J$ =12.12 Hz, 1H) 3.17-3.29 (m, 3H) 3.35-3.46 (m, 1H) 4.21 (br. s, 1H) 4.88 (br. s, 1H) 6.79 (m, 1H) 7.26 (d,  $J$ =8.99 Hz, 2H) 7.83 (d,  $J$ =9.38 Hz, 3H) 8.08 (d,  $J$ =2.35 Hz, 1H) 8.51 (s, 1H) 8.60 (d,  $J$ =2.74 Hz, 1H) 8.76-8.81 (m, 1H) 10.15 (s, 1H).

Stage 212.1 (R)-5-Bromo-6-(3-hydroxypyrrolidin-1-yl)-N-(4-(1,1,2,2-tetrafluoroethoxy)phenyl)nicotinamide



The title compound was prepared in an analogous fashion to that described in Stage 33.1 using 5-bromo-6-chloro-N-(4-(1,1,2,2-tetrafluoroethoxy)phenyl)nicotinamide (Stage 212.2) and (R)-pyrrolidin-3-ol to afford a solid. UPLC-MS (Condition 3)  $t_R$ =1.05 min,  $m/z$ =478.1  $[\text{M}+\text{H}]^+$ .

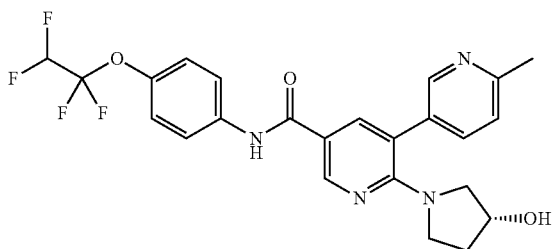
Stage 212.2 5-Bromo-6-chloro-N-(4-(1,1,2,2-tetrafluoroethoxy)phenyl)nicotinamide



The title compound was prepared in an analogous fashion to that described in Stage 169.2 using 5-bromo-6-chloro-nicotinic acid and 4-(1,1,2,2-tetrafluoroethoxy)aniline to afford a solid. UPLC-MS (Condition 3),  $t_R$ =1.2 min,  $m/z$ =424.9  $[\text{M}+\text{H}]^+$ .

## Example 213

(R)-2-(3-Hydroxypyrrolidin-1-yl)-6'-methyl-N-(4-(1,1,2,2-tetrafluoroethoxy)phenyl)-[3,3'-bipyridine]-5-carboxamide

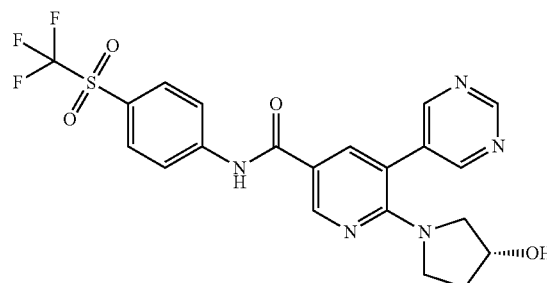


## 234

The title compound was prepared in an analogous fashion to that described in Example 151 using (R)-5-bromo-6-(3-hydroxypyrrolidin-1-yl)-N-(4-(1,1,2,2-tetrafluoroethoxy)phenyl)nicotinamide (Stage 212.1) and (6-methylpyridin-3-yl)boronic acid to afford a solid. UPLC-MS (Condition 3),  $t_R$ =0.87 min,  $m/z$ =491.3;  $^1\text{H-NMR}$  (400 MHz, DMSO- $d_6$ ),  $\delta$  ppm 1.74 (br. s, 1H) 1.83 (d,  $J$ =8.60 Hz, 1H) 2.53 (s, 3H) 2.88 (d,  $J$ =11.73 Hz, 1H) 3.20 (dd,  $J$ =11.73, 4.69 Hz, 2H) 3.33-3.45 (m, 1H) 4.19 (br. s, 1H) 4.84 (d,  $J$ =3.13 Hz, 1H) 6.79 (m, 1H) 7.25 (m,  $J$ =8.60 Hz, 2H) 7.34 (d,  $J$ =8.21 Hz, 1H) 7.69 (d,  $J$ =8.21 Hz, 1H) 7.83 (m,  $J$ =8.99 Hz, 2H) 7.99 (s, 1H) 8.49 (s, 1H) 8.75 (d,  $J$ =2.35 Hz, 1H) 10.13 (s, 1H).

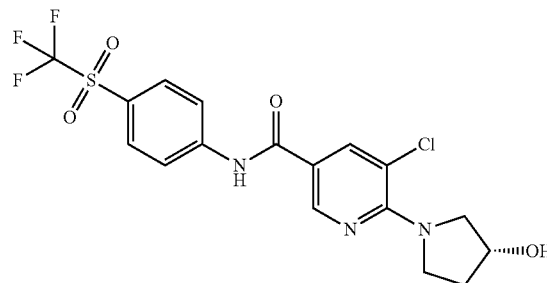
## Example 214

(R)-6-(3-Hydroxypyrrolidin-1-yl)-5-(pyrimidin-5-yl)-N-(4-((trifluoromethyl)sulfonyl)phenyl)nicotinamide



The title compound was prepared in an analogous fashion to that described in Example 151 using (R)-5-chloro-6-(3-hydroxypyrrolidin-1-yl)-N-(4-((trifluoromethyl)sulfonyl)phenyl)nicotinamide (Stage 214.1) and pyrimidin-5-ylboronic acid to afford a solid. UPLC-MS (Condition 3),  $t_R$ =0.92 min,  $m/z$ =492.3;  $^1\text{H-NMR}$  (400 MHz, DMSO- $d_6$ ),  $\delta$  ppm 1.74 (br. s, 1H) 1.85 (br. s, 1H) 2.91 (d,  $J$ =10.95 Hz, 1H) 3.18-3.26 (m, 2H) 3.32-3.45 (m, 1H) 4.22 (br. s, 1H) 4.90 (d,  $J$ =3.52 Hz, 1H) 8.05-8.16 (m, 3H) 8.16-8.25 (m, 2H) 8.81-8.86 (m, 1H) 8.90 (s, 2H) 9.20 (s, 1H) 10.65 (s, 1H).

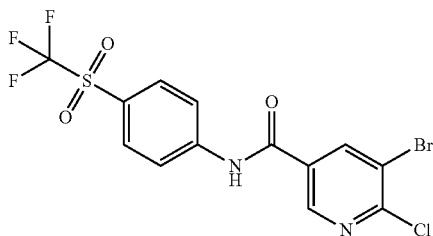
Stage 214.1 (R)-5-Chloro-6-(3-hydroxypyrrolidin-1-yl)-N-(4-((trifluoromethyl)sulfonyl)phenyl)nicotinamide



The title compound was prepared in an analogous fashion to that described in Stage 33.1 using 5-bromo-6-chloro-N-(4-((trifluoromethyl)sulfonyl)phenyl)nicotinamide (Stage 214.2) and (R)-pyrrolidin-3-ol to afford a solid. UPLC-MS (Condition 3)  $t_R$ =1.11 min,  $m/z$ =494.1  $[\text{M}+\text{H}]^+$ .

## 235

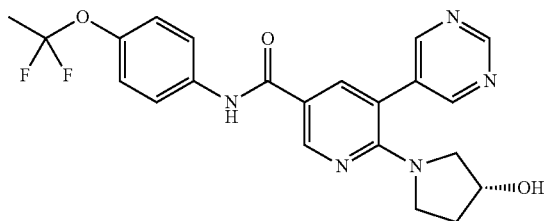
Stage 214.2 5-Bromo-6-chloro-N-(4-((trifluoromethyl)sulfonyl)phenyl)nicotinamide



The title compound was prepared in an analogous fashion to that described in Stage 169.2 using 5-bromo-6-chloro-nicotinic acid and 4-trifluoromethanesulfonyl-aniline to afford a solid. UPLC-MS (Condition 3)  $t_R$ =1.23 min,  $m/z$ =441 [M+H]<sup>+</sup>.

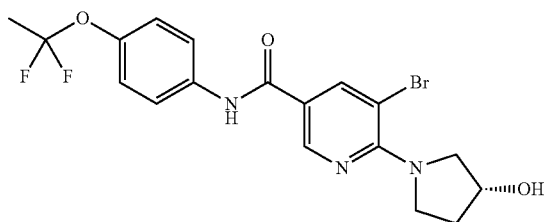
## Example 215

(R)-N-(4-(1,1-Difluoroethoxy)phenyl)-6-(3-hydroxypyrrolidin-1-yl)-5-(pyrimidin-5-yl)nicotinamide



The title compound was prepared in an analogous fashion to that described in Example 185 using (R)-5-bromo-N-(4-(1,1-difluoroethoxy)phenyl)-6-(3-hydroxypyrrolidin-1-yl)nicotinamide (Stage 215.1) and pyrimidin-5-ylboronic acid to afford an off-white foam. HPLC (Condition 4)  $t_R$ =4.28 min, UPLC-MS (Condition 3)  $t_R$ =0.84 min,  $m/z$ =442.4 [M+H]<sup>+</sup>; <sup>1</sup>H-NMR (400 MHz, DMSO-d<sub>6</sub>)  $\delta$  ppm 1.74 (m, J=4.30 Hz, 1H) 1.81-1.99 (m, 4H) 2.87 (d, J=11.34 Hz, 1H) 3.21 (m, J=11.30, 4.70 Hz, 2H) 3.37 (m, J=7.00 Hz, 1H) 4.15-4.24 (m, 1H) 4.86 (d, J=3.52 Hz, 1H) 7.16 (d, J=8.99 Hz, 2H) 7.74 (d, J=8.60 Hz, 2H) 8.08 (d, J=1.95 Hz, 1H) 8.77 (d, J=1.00 Hz, 1H) 8.87 (s, 2H) 9.18 (s, 1H) 10.06 (s, 1H).

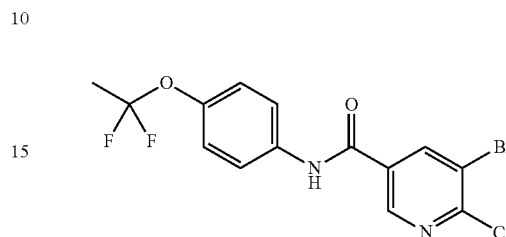
Stage 215.1 (R)-5-Bromo-N-(4-(1,1-difluoroethoxy)phenyl)-6-(3-hydroxypyrrolidin-1-yl)nicotinamide



## 236

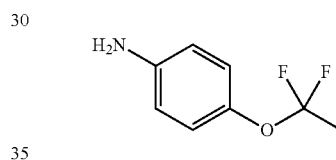
The title compound was prepared in an analogous fashion to that described in Stage 33.1 using 5-bromo-6-chloro-N-(4-(1,1-difluoroethoxy)phenyl)nicotinamide (Stage 215.2) and (R)-pyrrolidin-3-ol to afford a white solid. HPLC (Condition 5)  $t_R$ =5.11 min, UPLC-MS (Condition 3)  $t_R$ =1.02 min,  $m/z$ =440.3 [M-H]<sup>-</sup>.

Stage 215.2 5-Bromo-6-chloro-N-(4-(1,1-difluoroethoxy)phenyl)nicotinamide



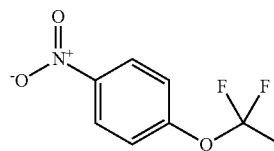
The title compound was prepared in an analogous fashion to that described in Stage 185.2 using 5-bromo-6-chloro-nicotinic acid and 4-(1,1-difluoroethoxy)aniline (Stage 215.3) to afford an off-white crystalline solid. HPLC (Condition 5)  $t_R$ =7.3 min, UPLC-MS (Condition 3)  $t_R$ =1.16 min,  $m/z$ =391/393 [M+H]<sup>+</sup>.

Stage 215.3 4-(1,1-Difluoroethoxy)aniline



A solution of 1-(1,1-difluoroethoxy)-4-nitrobenzene (Stage 30.4, 2.95 g, 13.94 mmol) in EtOH (100 mL) was hydrogenated (Raney Ni 1.0 g; 26.5 h at RT). The RM was filtered through Hyflo® and the solvent was evaporated off under reduced pressure to give the crude title product as a brown oil. HPLC (Condition 5)  $t_R$ =4.5 min, UPLC-MS (Condition 3)  $t_R$ =0.74 min,  $m/z$ =174.1 [M+H]<sup>+</sup>.

Stage 215.4 1-(1,1-Difluoroethoxy)-4-nitrobenzene

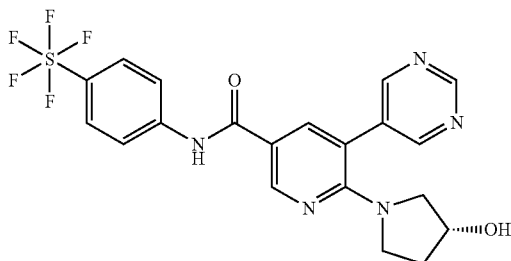


4-Nitroacetophenone (2.45 g, 14.54 mmol) and HF-pyridine (10.11 mL, 116 mmol) was added to a mixture of XeF<sub>2</sub> (4.92 g, 29.1 mmol) and DCM (50 mL) in a plastic vial and the RM was stirred at RT for 20 h. The RM was added carefully to a stirred mixture of EtOAc (150 mL) and sat. NaHCO<sub>3</sub> (250 mL) and extracted with EtOAc. The combined extracts were washed with brine (2x100 mL), dried over Na<sub>2</sub>SO<sub>4</sub> and the solvent was evaporated off under reduced pressure to give a crude product which was purified by flash chromatography (Silica gel column, 40 g, n-hexane/EtOAc (95:5)) to give the title product as a yellow oil. HPLC (Condition 4)  $t_R$ =5.43 min, UPLC-MS (Condition 3)  $t_R$ =1.05 min.

## 237

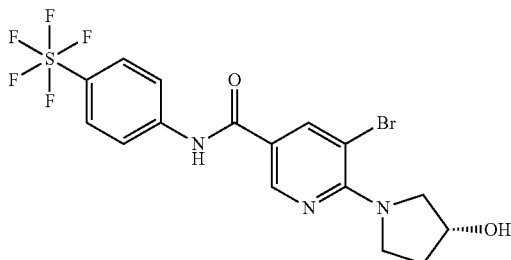
## Example 216

(R)-6-(3-Hydroxypyrrolidin-1-yl)-5-(pyrimidin-5-yl)-N-(4-(pentafluorosulfanyl)phenyl)nicotinamide



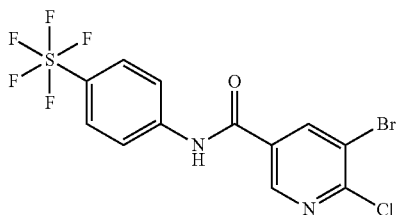
The title compound was prepared in an analogous fashion to that described in Example 151 using (R)-5-bromo-6-(3-hydroxypyrrolidin-1-yl)-N-(4-(pentafluorosulfanyl)phenyl)nicotinamide (Stage 216.1) and pyrimidin-5-ylboronic acid to afford a solid. UPLC-MS (Condition 3),  $t_R$ =0.97 min,  $m/z$ =488.2  $[M+H]^+$ ;  $^1H$ -NMR (400 MHz, DMSO- $d_6$ ),  $\delta$  ppm 1.74 (m, 1H) 1.84 (m,  $J$ =8.99 Hz, 1H) 2.88 (d,  $J$ =10.95 Hz, 1H) 3.18-3.26 (m, 2H) 3.33-3.43 (m, 1H) 4.20 (br. s, 1H) 4.83-4.97 (m, 1H) 7.80-7.88 (m, 2H) 7.91-7.99 (m, 2H) 8.10 (d,  $J$ =1.00 Hz, 1H) 8.80 (d,  $J$ =1.96 Hz, 1H) 8.88 (s, 2H) 9.18 (s, 1H) 10.36 (br. s, 1H).

Stage 216.1 (R)-5-Bromo-6-(3-hydroxypyrrolidin-1-yl)-N-(4-(pentafluorosulfanyl)phenyl)nicotinamide



The title compound was prepared in an analogous fashion to that described in Stage 33.1 using 5-bromo-6-chloro-N-(4-(pentafluorosulfanyl)phenyl)nicotinamide (Stage 216.2) and (R)-pyrrolidin-3-ol to afford a solid. UPLC-MS (Condition 3)  $t_R$ =1.16 min,  $m/z$ =490.1.

Stage 216.2 5-bromo-6-chloro-N-(4-(pentafluorosulfanyl)phenyl)nicotinamide

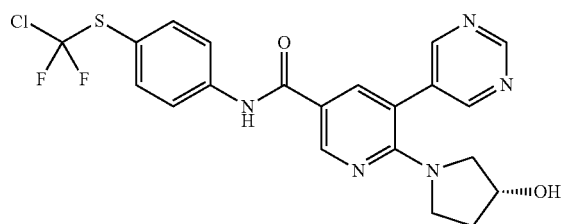


## 238

The title compound was prepared in an analogous fashion to that described infashion to that described in Stage 185.2 using 5-Bromo-6-chloro-nicotinic acid and 4-aminophenyl-sulfur pentafluoride to afford an orange solid. HPLC (Condition 4),  $t_R$ =6.43 min, UPLC-MS (Condition 3)  $t_R$ =1.27 min,  $m/z$ =435.3/437.2.

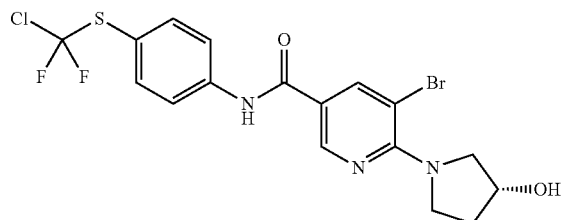
## Example 217

(R)-N-(4-((Chlorodifluoromethyl)thio)phenyl)-6-(3-hydroxypyrrolidin-1-yl)-5-(pyrimidin-5-yl)nicotinamide



The title compound was prepared in an analogous fashion to that described infashion to that described in Example 185 using (R)-5-bromo-N-(4-((chlorodifluoromethyl)thio)phenyl)-6-(3-hydroxypyrrolidin-1-yl)nicotinamide (Stage 217.1) and pyrimidin-5-ylboronic acid to afford an off-white foam. HPLC (Condition 4)  $t_R$ =5.27 min, UPLC-MS (Condition 3)  $t_R$ =1.00 min,  $m/z$ =478.3  $[M+H]^+$ ;  $^1H$ -NMR (400 MHz, DMSO- $d_6$ )  $\delta$  ppm 1.66-1.78 (m, 1H) 1.80-1.90 (m, 1H) 2.88 (d,  $J$ =11.34 Hz, 1H) 3.21 (m,  $J$ =10.90, 4.30 Hz, 2H) 3.32-3.44 (m, 1H) 4.12-4.26 (m, 1H) 4.87 (d,  $J$ =3.52 Hz, 1H) 7.67 (d,  $J$ =8.60 Hz, 2H) 7.91 (d,  $J$ =8.99 Hz, 2H) 8.09 (d,  $J$ =2.35 Hz, 1H) 8.79 (d,  $J$ =2.35 Hz, 1H) 8.88 (s, 2H) 9.13-9.33 (m, 1H) 10.27 (s, 1H).

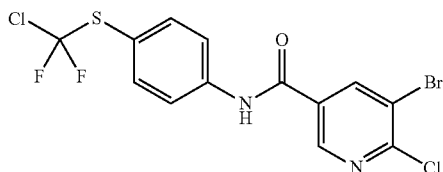
Stage 217.1 (R)-5-Bromo-N-(4-((chlorodifluoromethyl)thio)phenyl)-6-(3-hydroxypyrrolidin-1-yl)nicotinamide



The title compound was prepared in an analogous fashion to that described infashion to that described in Stage 33.1 using 5-bromo-6-chloro-N-(4-((chlorodifluoromethyl)thio)phenyl)nicotinamide (Stage 217.2) and (R)-pyrrolidin-3-ol to afford an off-white crystalline solid. HPLC (Condition 4)  $t_R$ =5.97 min, UPLC-MS (Condition 3)  $t_R$ =1.19 min,  $m/z$ =478.2/480.1  $[M+H]^+$ .

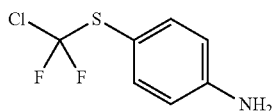
## 239

Stage 217.2 5-Bromo-6-chloro-N-(4-((chlorodifluoromethyl)thio)phenyl)-nicotinamide



The title compound was prepared in an analogous fashion to that described in Stage 11.2 using 5-bromo-6-chloro-nicotinic acid and 4-((chloro-difluoromethyl)thio)aniline (Stage 217.3) to afford an off-white crystalline solid. HPLC (Condition 4)  $t_R$ =6.78 min, UPLC-MS (Condition 3)  $t_R$ =1.32 min,  $m/z$ =425  $[M-H]^-$ .

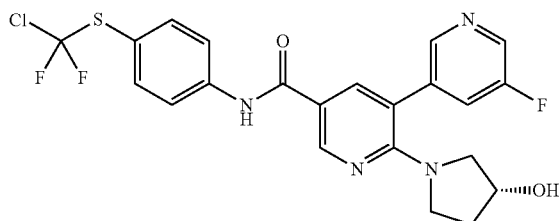
Stage 217.3: 4-((Chlorodifluoromethyl)thio)aniline



To a solution of 4-nitrophenylchlorodifluoromethyl sulfide (prepared as described in DE2845997, 627, 67.5 g, 0.28 mol) in ethanol (270 mL) and water (68 mL) stirred at 72° C. was added concentrated HCl (3.4 mL, 41.5 mmol) and iron powder (203 g, 3.63 mol) in three portions over 10 min. The RM was stirred at 82° C. for 30 min, filtered through Celite® (EtOH), the solvent was evaporated off under reduced pressure to give a yellow oil which was dissolved in DCM and washed with sat.  $\text{NaHCO}_3$  and brine. The organic phase was dried over  $\text{MgSO}_4$ , filtered and the filtrate was evaporated off under reduced pressure to give the crude product as a yellow oil which was distilled (b.p. 88-92° C., 0.9 mmHg) and filtered through Celite® to afford the title compound as a pale yellow oil.  $^1\text{H-NMR}$  (300 MHz,  $\text{CDCl}_3$ )  $\delta$  ppm 3.98 (br. s, 2H) 6.67 (dd, 2H) 7.43 (dd, 2H).

## Example 218

(R)-N-(4-((Chlorodifluoromethyl)thio)phenyl)-5'-fluoro-2-(3-hydroxypyrrolidin-1-yl)-[3,3'-bipyridine]-5-carboxamide



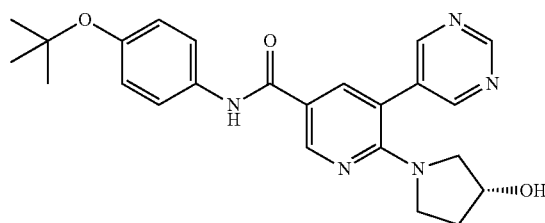
The title compound was prepared in an analogous fashion to that described infashion to that described in Example 185

## 240

using (R)-5-bromo-N-(4-((chlorodifluoromethyl)thio)phenyl)-6-(3-hydroxypyrrolidin-1-yl)nicotinamide (Stage 217.1) and 3-fluoro-5-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)pyridine to afford an off-white foam. HPLC (Condition 4)  $t_R$ =5.69 min, UPLC-MS (Condition 3)  $t_R$ =1.09 min,  $m/z$ =495.3  $[M+H]^+$ ;  $^1\text{H-NMR}$  (400 MHz,  $\text{DMSO-d}_6$ )  $\delta$  ppm 1.65-1.77 (m, 1H) 1.79-1.89 (m, 1H) 2.87 (d,  $J$ =11.34 Hz, 1H) 3.20 (m,  $J$ =11.10, 4.50 Hz, 2H) 3.33-3.44 (m, 1H) 4.19 (br. s, 1H) 4.86 (d,  $J$ =3.13 Hz, 1H) 7.66 (d,  $J$ =8.60 Hz, 2H) 7.82 (d,  $J$ =9.78 Hz, 1H) 7.91 (d,  $J$ =8.60 Hz, 2H) 8.06 (d,  $J$ =1.00 Hz, 1H) 8.50 (s, 1H) 8.58 (d,  $J$ =2.35 Hz, 1H) 8.77 (d,  $J$ =1.95 Hz, 1H) 10.27 (s, 1H).

## Example 219

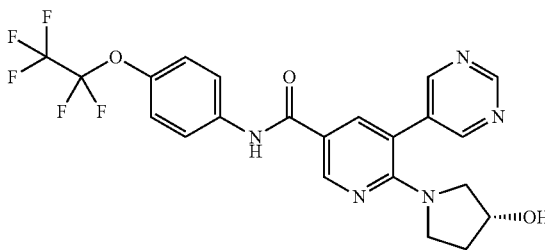
(R)-N-(4-(tert-Butoxy)phenyl)-6-(3-hydroxypyrrolidin-1-yl)-5-(pyrimidin-5-yl)nicotinamide



The title compound was prepared in an analogous fashion to that described infashion to that described in Example 170 using (R)-6-(3-hydroxypyrrolidin-1-yl)-5-(pyrimidin-5-yl)nicotinic acid (Stage 170.1) and 4-tert-butoxyaniline to afford an off-white foam. HPLC (Condition 4)  $t_R$ =4.31 min, UPLC-MS (Condition 3)  $t_R$ =0.84 min,  $m/z$ =434.4  $[M+H]^+$ ;  $^1\text{H-NMR}$  (400 MHz,  $\text{DMSO-d}_6$ )  $\delta$  ppm 1.26 (s, 9H) 1.67-1.77 (m, 1H) 1.79-1.91 (m, 1H) 2.88 (d,  $J$ =3.91 Hz, 1H) 3.14-3.25 (m, 2H) 3.30-3.45 (m, 1H) 4.14-4.24 (m, 1H) 4.86 (d,  $J$ =3.52 Hz, 1H) 6.88-7.00 (m, 2H) 7.56-7.66 (m, 2H) 8.07 (d,  $J$ =2.35 Hz, 1H) 8.76 (d,  $J$ =2.35 Hz, 1H) 8.87 (d,  $J$ =0.78 Hz, 2H) 9.17 (s, 1H) 9.92 (s, 1H).

## Example 220

(R)-6-(3-Hydroxypyrrolidin-1-yl)-N-(4-(perfluoroethoxy)phenyl)-5-(pyrimidin-5-yl)nicotinamide

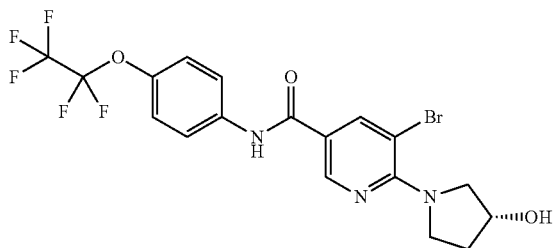


The title compound was prepared in an analogous fashion to that described infashion to that described in Example 185 using (R)-5-bromo-6-(3-hydroxypyrrolidin-1-yl)-N-(4-(perfluoroethoxy)phenyl)nicotinamide (Stage 220.1) and pyrimi-

## 241

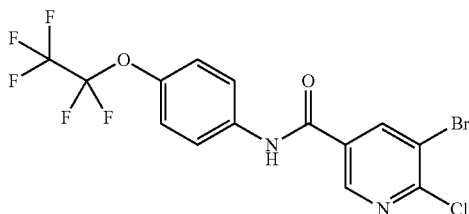
din-5-ylboronic acid to afford an off-white solid. HPLC (Condition 4)  $t_R$ =5.17 min, UPLC-MS (Condition 3)  $t_R$ =0.99 min,  $m/z$ =496.4  $[M+H]^+$ ;  $^1H$ -NMR (400 MHz, DMSO- $d_6$ )  $\delta$  ppm 1.66-1.77 (m, 1H) 1.79-1.91 (m, 1H) 2.88 (d,  $J$ =11.34 Hz, 1H) 3.21 (m,  $J$ =11.10, 4.90 Hz, 2H) 3.32-3.44 (m, 1H) 4.20 (d,  $J$ =2.35 Hz, 1H) 4.87 (d,  $J$ =3.52 Hz, 1H) 7.33 (d,  $J$ =8.60 Hz, 2H) 7.85 (d,  $J$ =9.38 Hz, 2H) 8.08 (d,  $J$ =2.35 Hz, 1H) 8.78 (d,  $J$ =2.35 Hz, 1H) 8.88 (s, 2H) 9.13-9.34 (m, 1H) 10.16 (s, 1H).

Stage 220.1 (R)-5-Bromo-6-(3-hydroxypyrrolidin-1-yl)-N-(4-(perfluoroethoxy)phenyl)nicotinamide



The title compound was prepared in an analogous fashion to that described infashion to that described in Stage 33.1 using 5-bromo-6-chloro-N-(4-(perfluoroethoxy)phenyl)nicotinamide (Stage 220.2) and (R)-pyrrolidin-3-ol to afford an off-white crystalline solid. HPLC (Condition 4)  $t_R$ =6.01 min, UPLC-MS (Condition 3)  $t_R$ =1.17 min,  $m/z$ =496.2  $[M+H]^+$ .

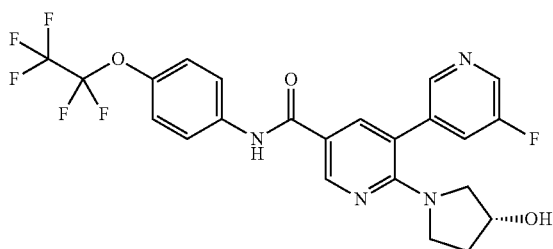
Stage 220.2 5-Bromo-6-chloro-N-(4-(perfluoroethoxy)phenyl)nicotinamide



The title compound was prepared in an analogous fashion to that described infashion to that described in Stage 169.2 using 5-bromo-6-chloro-nicotinic acid and 4-(perfluoroethoxy)aniline to afford an off-white crystalline solid. HPLC (Condition 4)  $t_R$ =6.73 min, UPLC-MS (Condition 3)  $t_R$ =1.30 min,  $m/z$ =443.1  $[M-H]^-$ .

## Example 221

(R)-5'-Fluoro-2-((R)-3-hydroxypyrrolidin-1-yl)-N-(4-(perfluoroethoxy)phenyl)-[3,3'-bipyridine]-5-carboxamide

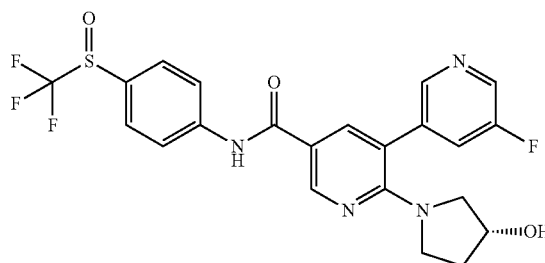


## 242

The title compound was prepared in an analogous fashion to that described in Example 185 using (R)-5-bromo-6-(3-hydroxypyrrolidin-1-yl)-N-(4-(perfluoroethoxy)phenyl)nicotinamide (Stage 220.1) and 3-fluoro-5-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)pyridine to afford an off-white foam. HPLC (Condition 4)  $t_R$ =5.58 min, UPLC-MS (Condition 3)  $t_R$ =1.07 min,  $m/z$ =513.4  $[M+H]^+$ ;  $^1H$ -NMR (400 MHz, DMSO- $d_6$ )  $\delta$  ppm 1.67-1.76 (m, 1H) 1.78-1.89 (m, 1H) 2.86 (d,  $J$ =11.34 Hz, 1H) 3.13-3.26 (m, 2H) 3.33-3.43 (m, 1H) 4.19 (br. s, 1H) 4.85 (d,  $J$ =3.13 Hz, 1H) 7.33 (d,  $J$ =8.99 Hz, 2H) 7.76-7.90 (m, 3H) 8.03-8.09 (m, 1H) 8.49 (s, 1H) 8.58 (d,  $J$ =2.74 Hz, 1H) 8.72-8.82 (m, 1H) 8.99-9.00 (m, OH) 10.16 (s, 1H).

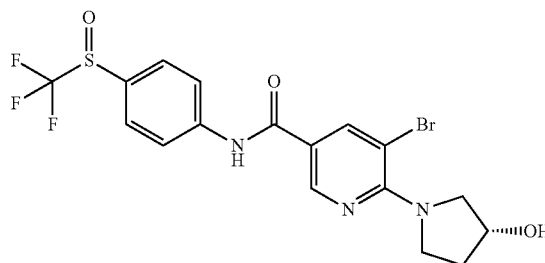
## Example 222

5'-Fluoro-2-((R)-3-hydroxypyrrolidin-1-yl)-N-(4-((trifluoromethyl)sulfinyl)phenyl)-[3,3'-bipyridine]-5-carboxamide



The title compound was prepared in an analogous fashion to that described in Example 185 using 5-bromo-6-((R)-3-hydroxypyrrolidin-1-yl)-N-(4-((trifluoromethyl)sulfinyl)phenyl)nicotinamide (Stage 222.1) and 3-fluoro-5-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)pyridine to afford an off-white foam. HPLC (Condition 4)  $t_R$ =4.46 min, UPLC-MS (Condition 3)  $t_R$ =0.87 min,  $m/z$ =495.3  $[M+H]^+$ ;  $^1H$ -NMR (400 MHz, DMSO- $d_6$ )  $\delta$  ppm 1.65-1.78 (m, 1H) 1.79-1.88 (m, 1H) 2.88 (d,  $J$ =1.00 Hz, 1H) 3.22 (m,  $J$ =4.70 Hz, 2H) 3.34-3.44 (m, 1H) 4.14-4.23 (m, 1H) 4.86 (d,  $J$ =3.52 Hz, 1H) 7.86 (d,  $J$ =8.99 Hz, 3H) 8.01-8.14 (m, 3H) 8.50 (s, 1H) 8.59 (d,  $J$ =2.74 Hz, 1H) 8.79 (d,  $J$ =2.35 Hz, 1H) 10.40 (s, 1H).

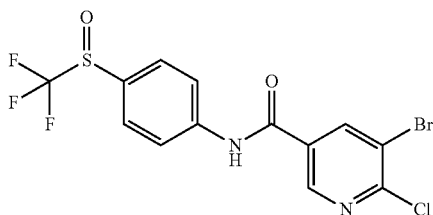
Stage 222.1 5-Bromo-6-((R)-3-hydroxypyrrolidin-1-yl)-N-(4-((trifluoromethyl)sulfinyl)phenyl)nicotinamide



The title compound was prepared in an analogous fashion to that described in Stage 33.1 using 5-bromo-6-chloro-N-(4-((trifluoromethyl)sulfinyl)phenyl)nicotinamide (Stage 222.2) and (R)-pyrrolidin-3-ol to afford an amorphous off-white solid. HPLC (Condition 4)  $t_R$ =4.83 min, UPLC-MS (Condition 3)  $t_R$ =0.95 min,  $m/z$ =478.2  $[M+H]^+$ .

## 243

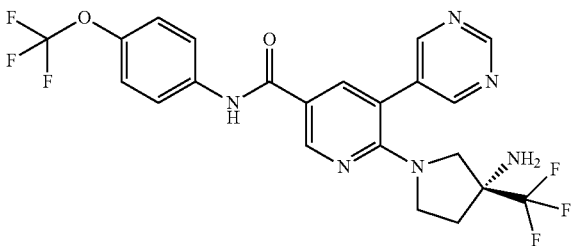
Stage 222.2 5-Bromo-6-chloro-N-(4-((trifluoromethyl)sulfinyl)phenyl)nicotinamide



The title compound was prepared in an analogous fashion to that described in Stage 169.2 using 5-bromo-6-chloro-nicotinic acid and 4-(trifluoromethylsulfinyl)aniline To afford an off-white crystalline solid. HPLC (Condition 4)  $t_R$ =5.59 min, UPLC-MS (Condition 3)  $t_R$ =1.10 min,  $m/z$ =425 [M-H]<sup>-</sup>.

## Example 223

(R)-6-(3-Amino-3-(trifluoromethyl)pyrrolidin-1-yl)-5-(pyrimidin-5-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide

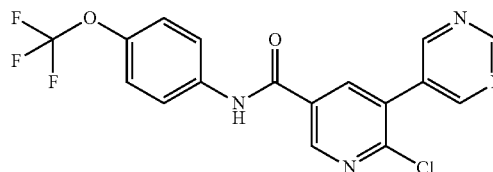


6-Chloro-5-(pyrimidin-5-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 223.1, 150 mg, 0.380 mmol) was suspended in iPrOH (0.6 mL). tert-Butyl[3-(trifluoromethyl)pyrrolidine-3-yl]carbamate (193 mg, 0.760 mmol) and DIPEA (0.265 mL, 1.520 mmol) were added at RT. The pink/red suspension was stirred at 140° C. for 22 h. The orange reaction solution was diluted with EtOAc (50 mL) then washed with a 2 N citric acid solution (20 mL) and water (3×20 mL). Aq. phases were back-extracted with EtOAc (40 mL). The combined organic phases were dried over Na<sub>2</sub>SO<sub>4</sub>, filtered, and the solvent was evaporated off under reduced pressure to give a crude product that was purified by flash chromatography (RediSep® Silica gel column, 40 g, DCM/EtOAc 7:3). The resulting intermediate (135 mg, 0.22 mmol) was suspended in DCM (2 mL). TFA (0.679 mL, 8.82 mmol) was added at RT and the resulting light yellow solution was stirred for 2 h at RT. The RM was diluted with EtOAc (50 mL), washed with an aq. sat. solution of NaHCO<sub>3</sub> (2×20 mL) and water (2×20 mL). Aq. phases were back-extracted with EtOAc (40 mL). The combined organic phases were dried over Na<sub>2</sub>SO<sub>4</sub>, filtered, and the solvent was evaporated off under reduced pressure to give a crude product that was suspended in MeCN (2 mL). The white suspension was stirred for 30 min at RT then filtered. The solid was washed

## 244

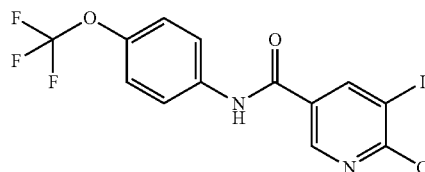
with MeCN (2 mL) and dried under reduced pressure to give the title product as a white solid. HPLC (Condition 10)  $t_R$ =5.748 min, UPLC-MS (Condition 3)  $t_R$ =1.03 min,  $m/z$ =513.1 [M+H]<sup>+</sup>; <sup>1</sup>H-NMR (400 MHz, DMSO-d<sub>6</sub>) δ ppm 1.75-1.85 (m, 1H) 1.96-2.08 (m, 1H) 2.24-2.35 (m, 2H) 3.13-3.26 (m, 2H) 3.36-3.52 (m, 2H) 7.36 (d, J=8.99 Hz, 2H) 7.86 (d, J=8.99 Hz, 2H) 8.14 (d, J=2.35 Hz, 1H) 8.81 (d, J=2.35 Hz, 1H) 8.92 (s, 2H) 9.22 (s, 1H) 10.22 (s, 1H).

Stage 223.1 6-Chloro-5-(pyrimidin-5-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide



A mixture of 6-chloro-5-iodo-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 223.2, 5.7 g, 12.75 mmol), pyrimidine-5-boronic acid (2.5 g, 19.77 mmol), PdCl<sub>2</sub>(dppf) (CH<sub>2</sub>Cl<sub>2</sub>) (0.625 g, 0.765 mmol), Na<sub>2</sub>CO<sub>3</sub> (19.13 mL, 38.3 mmol) and DME (100 mL) was stirred at 80° C. for 2.5 h under argon atmosphere. The RM was filtered through Hyflo®, diluted with EtOAc (100 mL), washed with a sat. aq. solution of NaHCO<sub>3</sub> and with brine, dried over Na<sub>2</sub>SO<sub>4</sub> and the solvent was evaporated off under reduced pressure to give the crude product which was purified by flash chromatography (Biotage Silica gel column, 120 g, n-hexane/EtOAc from 20% to 60% EtOAc) to give the title compound product as a pink crystalline solid. UPLC-MS (Condition 3)  $t_R$ =1.01 min, 393.2 [M-H]<sup>-</sup>; <sup>1</sup>H-NMR (400 MHz, DMSO-d<sub>6</sub>) δ ppm 7.42 (d, J=8.99 Hz, 2H) 7.88 (d, J=9.38 Hz, 2H) 8.56 (d, J=2.35 Hz, 1H) 9.03 (d, J=2.35 Hz, 1H) 9.10 (s, 2H) 9.32 (s, 1H) 10.69 (s, 1H).

Stage 223.2 6-Chloro-5-iodo-N-(4-(trifluoromethoxy)phenyl)nicotinamide



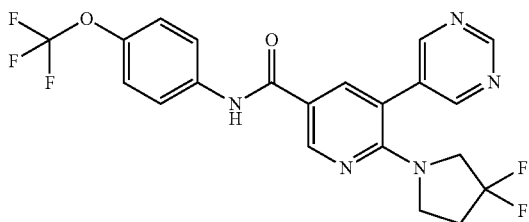
DMF (0.014 mL, 0.176 mmol) and oxalyl chloride (2.316 mL, 26.5 mmol) were added to a solution of 6-chloro-5-iodonicotinic acid (5 g, 17.64 mmol) in DCM (80 mL) and the RM was stirred for 2 h at RT under a nitrogen atmosphere. The solvent was evaporated off under reduced pressure and the residue was dissolved in THF (60 mL). DIPEA (9.24 mL, 52.9 mmol) was added and the mixture was cooled down to 5° C., treated dropwise with a solution of 4-(trifluoromethoxy)aniline (2.62 mL, 19.40 mmol) in DCM (20 mL) and stirred at 5° C. for 30 min and at RT for 1 h. The solvent was off under reduced pressure and the residue was treated with aq. 10%

## 245

citric acid (70 mL) and extracted with EtOAc. The combined extracts were washed with sat. aq. Na<sub>2</sub>CO<sub>3</sub> and brine, dried over Na<sub>2</sub>SO<sub>4</sub> and the solvent was evaporated off under reduced pressure to give the crude product was suspended in n-hexane, and filtered to afford the title compound as a beige solid. UPLC-MS (Condition 3)  $t_R$ =1.22 min, 440.9/442.9 [M-H]<sup>-</sup>.

## Example 224

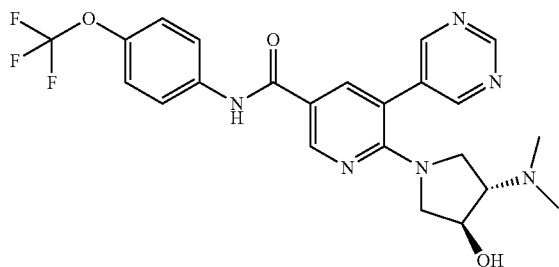
6-(3,3-Difluoropyrrolidin-1-yl)-5-(pyrimidin-5-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide



6-Chloro-5-(pyrimidin-5-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 223.1, 100 mg, 0.253 mmol) was suspended in iPrOH (0.5 mL). 3,3-Difluoropyrrolidine hydrochloride (72.7 mg, 0.507 mmol) and DIPEA (0.177 mL, 1.013 mmol) were added at RT. The light brown solution was stirred at 140° C. for 23 h. The RM was diluted with EtOAc (50 mL) and washed with a 2 N citric acid solution (20 mL) and water (3×20 mL). The combined aq. phases were extracted with EtOAc and the combined extracts were dried over Na<sub>2</sub>SO<sub>4</sub>, filtered, and the solvent was evaporated off under reduced pressure to give the crude material that was purified by flash chromatography (RediSep® Silica gel column, 24 g, DCM/EtOAc 7:3). The resulting product was dissolved in MeOH (2 mL). The resulting white suspension was stirred at RT for 15 min then filtered. The solid was washed with MeOH (5 mL) and dried to afford the title product as a white solid. HPLC (Condition 10)  $t_R$ =7.017 min, UPLC-MS (Condition 3)  $t_R$ =1.09 min,  $m/z$ =466.1 [M+H]<sup>+</sup>; <sup>1</sup>H-NMR (400 MHz, DMSO-d<sub>6</sub>) δ ppm 2.39 (spt, J=7.04 Hz, 2H) 3.37 (t, J=7.23 Hz, 2H) 3.62 (t, J=13.10 Hz, 2H) 7.37 (d, J=8.99 Hz, 2H) 7.82-7.89 (m, 2H) 8.15-8.19 (m, 1H) 8.82-8.85 (m, 1H) 8.94 (d, J=0.78 Hz, 2H) 9.23 (s, 1H) 10.27 (s, 1H).

## Example 225

6-((3S,4S)-3-(Dimethylamino)-4-hydroxypyrrolidin-1-yl)-5-(pyrimidin-5-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide

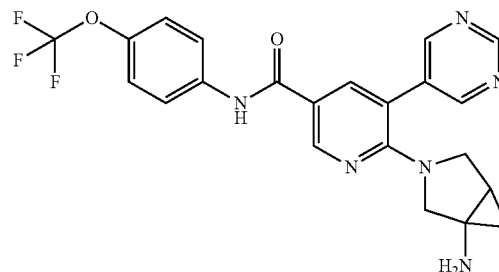


## 246

6-Chloro-5-(pyrimidin-5-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 223.1, 60 mg, 0.149 mmol) and DIPEA (0.182 mL, 1.043 mmol) were added to a vial containing iPrOH (1 mL). (3S,4S)-4-(Dimethylamino)pyrrolidin-3-ol (50 mg, 0.246 mmol) was added. The mixture was stirred at 110° C. for 16 h. The RM was treated with sat. aq. Na<sub>2</sub>CO<sub>3</sub> (20 mL) and was extracted with EtOAc. The combined extracts were washed with brine (10 mL), dried over Na<sub>2</sub>SO<sub>4</sub>, filtered and the filtrate was evaporated off under reduced pressure to give a crude product that was purified by preparative SFC (Column DEAP, from 13% to 18% in 6 min) to afford the title product as a white solid. HPLC (Condition 10)  $t_R$ =5.62 min, UPLC-MS (Condition 3)  $t_R$ =0.73 min,  $m/z$ =489.1 [M+H]<sup>+</sup>; <sup>1</sup>H-NMR (400 MHz, DMSO-d<sub>6</sub>) δ ppm 2.15 (s, 6H) 2.52-2.59 (m, 1H) 2.87 (dd, J=10.95, 5.08 Hz, 1H) 3.19 (dd, J=11.34, 5.90 Hz, 1H) 3.28 (m, J=11.30, 6.30 Hz, 1H) 3.45 (dd, J=11.34, 6.65 Hz, 1H) 4.08 (quin, J=5.08 Hz, 1H) 5.09 (d, J=5.08 Hz, 1H) 7.36 (d, J=8.60 Hz, 2H) 7.85 (m, J=9.00 Hz, 2H) 8.11 (d, J=2.35 Hz, 1H) 8.80 (d, J=2.35 Hz, 1H) 8.90 (s, 2H) 9.20 (s, 1H) 10.19 (s, 1H).

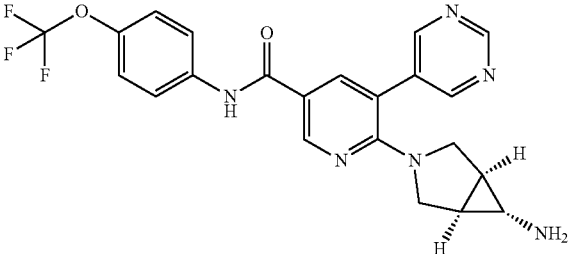
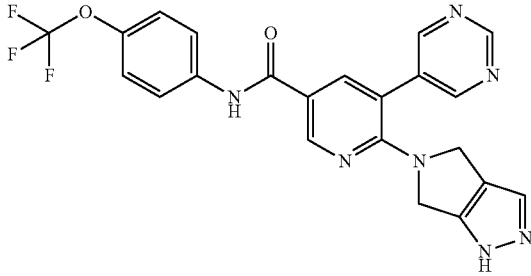
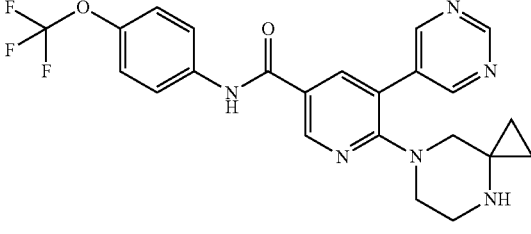
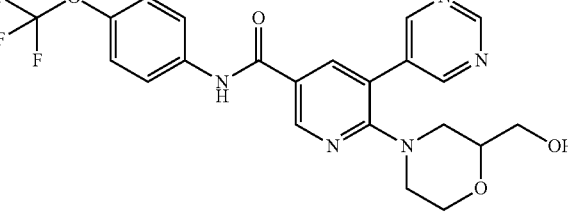
## Example 226

6-(1-Amino-3-azabicyclo[3.1.0]hexan-3-yl)-5-(pyrimidin-5-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide

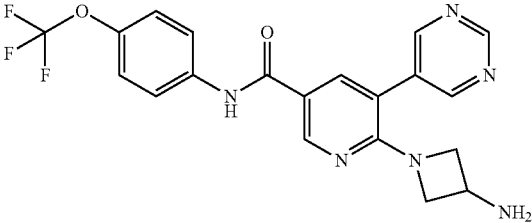
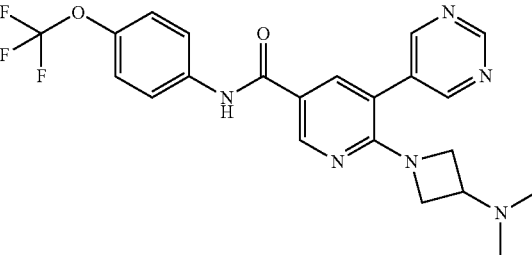
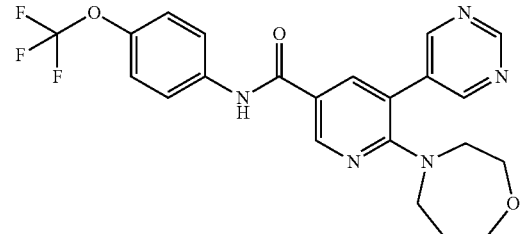


6-Chloro-5-(pyrimidin-5-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 223.1, 100 mg, 0.253 mmol) was dissolved in iPrOH (0.25 mL). DIPEA (97 μL, 2.2 mmol) was added and the RM mixture was stirred at 140° C. for 18 h in a pressure safe vial. The RM was cooled to RT, diluted with EtOAc and washed with brine. The organic layer was dried over Na<sub>2</sub>SO<sub>4</sub>, filtered and the filtrate was evaporated off under reduced pressure to give the intermediate which was dissolved in DCM (1.2 mL), cooled to 0° C. and treated with TFA (0.6 mL). The reaction mixture was stirred at RT for 3 h then neutralized with NaHCO<sub>3</sub>/water and extracted with EtOAc. The combined extracts were dried over Na<sub>2</sub>SO<sub>4</sub>, filtered and the filtrate was evaporated off under reduced pressure to give the crude product that was purified by preparative SFC to afford the title compound as an off-white amorphous powder. HPLC (Condition 4)  $t_R$ =4.18 min, UPLC-MS (Condition 3)  $t_R$ =0.75 min,  $m/z$ =457.1 [M+H]<sup>+</sup>; <sup>1</sup>H-NMR (400 MHz, DMSO-d<sub>6</sub>) δ ppm 0.30 (t, J=4.50 Hz, 1H) 0.76 (dd, J=8.21, 4.69 Hz, 1H) 1.26-1.37 (m, 1H) 3.10 (d, J=10.17 Hz, 1H) 3.31-3.50 (m, 5H) 7.33 (d, J=8.99 Hz, 2H) 7.76-7.88 (m, 2H) 8.05 (d, J=2.35 Hz, 1H) 8.75 (d, J=0.78 Hz, 1H) 8.88 (s, 2H) 9.20 (s, 1H) 10.17 (s, 1H).

The following examples were prepared in an analogous fashion to that described in the Example using the Stage and starting material as indicated.

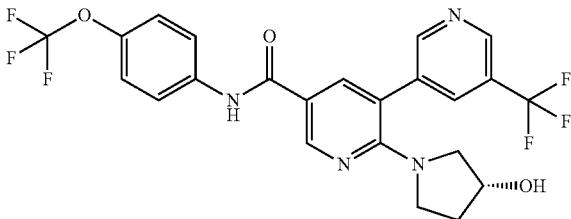
Ex.	Structure/Name	Example/Stage and starting material	Analytcs
227	 <p>6-((1R,5S,6s)-6-amino-3-azabicyclo[3.1.0]hexan-3-yl)-5-(pyrimidin-5-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide</p>	226/223.1 and tert-butyl (1R,5S,6s)-3-azabicyclo[3.1.0]hexan-6-ylcarbamate HPLC (Condition 4) $t_R = 4.19$ min, UPLC-MS (Condition 3) $t_R = 0.75$ min, $m/z = 457.1$ [M + H] <sup>+</sup> ; <sup>1</sup> H-NMR (400 MHz, DMSO- $d_6$ ) $\delta$ ppm 1.60 (br. s, 2 H) 2.03 (br. s, 1 H) 3.10-3.43 (m, 6 H) 7.33 (d, J = 8.99 Hz, 2 H) 7.77-7.87 (m, 2 H) 8.05 (d, J = 1.56 Hz, 1 H) 8.72-8.79 (m, 1 H) 8.88 (s, 2 H) 9.20 (s, 1 H) 10.17 (s, 1 H).	
228	 <p>5-(pyrimidin-5-yl)-6-(pyrrolo[3,4-c]pyrazol-5(1H,4H,6H)-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide</p>	224/223.1 and 1,4,5,6-tetrahydropyrrolo[3,4-c]pyrazole HPLC (Condition 10) $t_R = 5.92$ min, UPLC-MS (Condition 3) $t_R = 0.93$ min, $m/z = 468$ [M + H] <sup>+</sup> ; <sup>1</sup> H-NMR (400 MHz, DMSO- $d_6$ ) $\delta$ ppm 4.33 (d, J = 15.25 Hz, 4 H) 7.36 (d, J = 8.99 Hz, 2 H) 7.49 (br. s, 1 H) 7.86 (d, J = 8.99 Hz, 2 H) 8.09 (d, J = 2.35 Hz, 1 H) 8.88 (d, J = 1.95 Hz, 1 H) 8.99 (s, 2 H) 9.26 (s, 1 H) 10.23 (s, 1 H) 12.67 (br. s, 1 H).	
229	 <p>5-(pyrimidin-5-yl)-6-(4,7-diazaspiro[2.5]octan-7-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide</p>	226/223.1 and tert-butyl 4,7-diazaspiro[2.5]octane-4-carboxylate HPLC (Condition 4) $t_R = 4.19$ min, UPLC-MS (Condition 3) $t_R = 0.77$ min, $m/z = 471.1$ [M + H] <sup>+</sup> ; <sup>1</sup> H-NMR (400 MHz, DMSO- $d_6$ ) $\delta$ ppm 0.27-0.38 (m, 2 H) 0.42-0.53 (m, 2 H) 2.75 (br. s, 2 H) 3.04 (s, 2 H) 3.08-3.16 (m, 2 H) 3.30 (br. s, 1 H) 7.36 (d, J = 8.99 Hz, 2 H) 7.79-7.91 (m, 2 H) 8.20 (d, J = 2.35 Hz, 1 H) 8.80 (d, J = 2.35 Hz, 1 H) 9.08 (d, J = 0.78 Hz, 2 H) 9.20 (d, J = 0.78 Hz, 1 H) 10.34 (s, 1 H).	
230	 <p>6-(2-(hydroxymethyl)morpholino)-5-(pyrimidin-5-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide</p>	224/223.1 and 2-hydroxymethylmorpholine HPLC (Condition 10) $t_R = 5.96$ min, UPLC-MS (Condition 3) $t_R = 0.89$ min, $m/z = 476$ [M + H] <sup>+</sup> ; <sup>1</sup> H-NMR (400 MHz, DMSO- $d_6$ ) $\delta$ ppm 2.57-2.70 (m, 1 H) 2.80-2.92 (m, 1 H) 3.19-3.28 (m, 1 H) 3.31-3.49 (m, 3 H) 3.56 (d, J = 12.90 Hz, 1 H) 3.75 (d, J = 11.34 Hz, 1 H) 4.66 (t, J = 5.28 Hz, 1 H) 7.38 (d, J = 8.99 Hz, 2 H) 7.83-7.89 (m, 2 H) 8.21-8.25 (m, 1 H) 8.84 (dd, J = 2.30, 0.80 Hz, 1 H) 9.11 (d, J = 0.78 Hz, 2 H) 9.21 (d, J = 0.78 Hz, 1 H) 10.35 (s, 1 H).	

-continued

Ex.	Structure/Name	Example/Stage and starting material Analytics
231	 <p>6-(3-aminoazetidin-1-yl)-5-(pyrimidin-5-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide</p>	<p>226/223.1 and tert-butyl azetidin-3-ylcarbamate HPLC (Condition 10) <math>t_R</math> = 5.49 min, UPLC-MS (Condition 3) <math>t_R</math> = 0.73 min, <math>m/z</math> = 431.1 <math>[M + H]^+</math>; <math>^1H</math>-NMR (400 MHz, DMSO-<math>d_6</math> + <math>D_2O</math>) <math>\delta</math> ppm 1.98 (br. s, 2 H) 3.37 (dd, <math>J</math> = 8.99, 5.47 Hz, 2 H) 3.58- 3.67 (m, 1 H) 3.85 (t, <math>J</math> = 8.02 Hz, 2 H) 7.36 (d, <math>J</math> = 8.99 Hz, 2 H) 7.85 (m, <math>J</math> = 9.00 Hz, 2 H) 8.08 (d, <math>J</math> = 2.35 Hz, 1 H) 8.79 (d, <math>J</math> = 2.35 Hz, 1 H) 8.90 (s, 2 H) 9.22 (s, 1 H) 10.19 (s, 1 H).</p>
232	 <p>6-(3-(dimethylamino)azetidin-1-yl)-5-(pyrimidin-5-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide</p>	<p>225/223.1 and N,N-dimethylazetidin-3-amine HPLC (Condition 10) <math>t_R</math> = 5.72 min, UPLC-MS (Condition 3) <math>t_R</math> = 0.74 min, <math>m/z</math> = 459.2 <math>[M + H]^+</math>; <math>^1H</math>-NMR (400 MHz, DMSO-<math>d_6</math>) <math>\delta</math> ppm 1.99 (s, 6 H) 3.00 (quin, <math>J</math> = 5.86 Hz, 1 H) 3.54 (dd, <math>J</math> = 8.99, 5.08 Hz, 2 H) 3.71-3.78 (m, 2 H) 7.36 (d, <math>J</math> = 8.99 Hz, 2 H) 7.85 (m, <math>J</math> = 9.00 Hz, 2 H) 8.11 (d, <math>J</math> = 2.35 Hz, 1 H) 8.80 (d, <math>J</math> = 2.30 Hz, 1 H) 8.93 (d, <math>J</math> = 0.78 Hz, 2 H) 9.22 (d, <math>J</math> = 0.78 Hz, 1 H) 10.23 (s, 1 H).</p>
233	 <p>6-(1,4-oxazepan-4-yl)-5-(pyrimidin-5-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide</p>	<p>224/223.1 and 1,4-oxazepane HPLC (Condition 10) <math>t_R</math> = 6.39 min, UPLC-MS (Condition 3) <math>t_R</math> = 1.01 min, <math>m/z</math> = 460.1 <math>[M + H]^+</math>; <math>^1H</math>-NMR (400 MHz, DMSO-<math>d_6</math>) <math>\delta</math> ppm 1.74 (quin, <math>J</math> = 5.57 Hz, 2 H) 3.36-3.46 (m, 4 H) 3.56 (t, <math>J</math> = 5.28 Hz, 2 H) 3.66 (t, <math>J</math> = 4.30 Hz, 2 H) 7.37 (d, <math>J</math> = 8.99 Hz, 2 H) 7.81-7.90 (m, 2 H) 8.14 (d, <math>J</math> = 2.35 Hz, 1 H) 8.79 (d, <math>J</math> = 2.35 Hz, 1 H) 8.96 (s, 2 H) 9.20 (s, 1 H) 10.25 (s, 1 H).</p>

## Example 234

(R)-2-(3-Hydroxypyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)-5'-(trifluoromethyl)-[3,3'-bipyridine]-5-carboxamide



A mixture of (R)-5-bromo-6-(3-hydroxypyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 35.1, 112 mg, 0.25 mmol), (5-(trifluoromethyl)pyridin-3-yl)boronic acid (71.6 mg, 0.375 mmol) and  $Cs_2CO_3$  (163 mg, 0.5

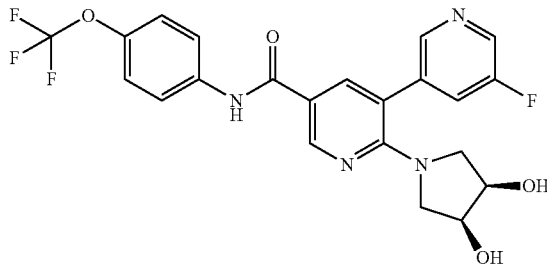
mmol) in degassed dioxane (3 mL) in a MW vial was evacuated/purged with argon.  $PdCl_2(dppf)-(CH_2Cl_2)$  (20.42 mg, 0.025 mmol) was added and the vial sealed. Water (0.6 mL) was added and the RM was stirred at 65° C. for 3.5 h. The solvent was evaporated off under reduced pressure to give a residue that was treated with water and extracted with EtOAc. The combined extracts were washed with water and brine, dried over  $MgSO_4$ /charcoal, filtered and the filtrate was evaporated off under reduced pressure to give a residue that was purified by flash chromatography (Silica gel column, 25 g, EtOAc). Palladium was removed using a SPE PL-Thiol MP cartridge (StratoSpheres™). The residue was dissolved in EtOAc and n-heptane was added. The solution was concentrated under reduced and the resulting suspension was stirred and filtered. The solid was washed with n-hexane then dried under HV at 45° C. to afford the title product as an amorphous white powder. UPLC-MS (Condition 3),  $t_R$  = 1.09 min,  $m/z$  = 513.1  $[M+H]^+$ ;  $^1H$ -NMR (600 MHz, DMSO- $d_6$ )  $\delta$  ppm 1.69-1.78 (m, 1H) 1.80-1.89 (m, 1H) 2.85 (d,  $J$  = 10.92 Hz, 1H) 3.13-3.26 (m, 2H) 3.27-3.40 (m, 1H) 4.20 (br. s, 1H) 4.88

## 251

(br. s, 1H) 7.36 (d, J=8.66 Hz, 2H) 7.85 (d, J=8.85 Hz, 2H) 8.11 (s, 1H) 8.27 (br. s, 1H) 8.79 (s, 1H) 8.93 (s, 1H) 8.99 (s, 1H) 10.19 (s, 1H).

## Example 235

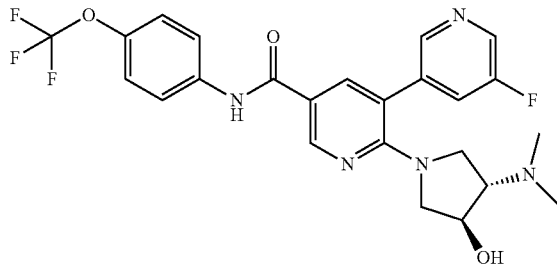
2-(cis-3,4-Dihydroxypyrrolidin-1-yl)-5'-fluoro-N-(4-(trifluoromethoxy)phenyl)-[3,3'-bipyridine]-5-carboxamide



The title compound was prepared in an analogous fashion to that described in Example 71 using 5-bromo-6-((3S,4R)-3,4-dihydroxypyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 71.1) and 5-fluoropyridin-3-ylboronic acid to afford a brown solid. UPLC-MS (Condition 3)  $t_R=0.92$  min,  $m/z=479.1$  [M+H]<sup>+</sup>,  $m/z=477.2$  [M-H]<sup>-</sup>; <sup>1</sup>H-NMR (400 MHz, DMSO-d<sub>6</sub>)  $\delta$  ppm 3.05 (dd, J=10.88, 4.28 Hz, 2H) 3.25 (dd, J=10.64, 5.01 Hz, 2H) 3.92-4.02 (m, 2H) 4.90 (d, J=3.79 Hz, 2H) 7.35 (d, J=8.44 Hz, 2H) 7.80-7.84 (m, 1H) 7.84-7.90 (m, 2H) 8.08 (d, J=2.32 Hz, 1H) 8.47-8.53 (m, 1H) 8.61 (d, J=2.69 Hz, 1H) 8.77 (d, J=2.32 Hz, 1H) 10.19 (s, 1H).

## Example 236

2-((3S,4S)-3-(Dimethylamino)-4-hydroxypyrrolidin-1-yl)-5'-fluoro-N-(4-(trifluoromethoxy)phenyl)-[3,3'-bipyridine]-5-carboxamide

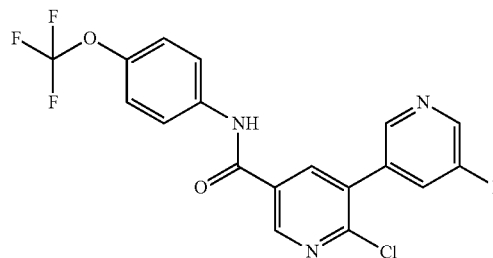


2-Chloro-5'-fluoro-N-(4-(trifluoromethoxy)phenyl)-[3,3'-bipyridine]-5-carboxamide (Stage 236.1, 60 mg, 0.137 mmol) and DIPEA (0.167 mL, 0.959 mmol) were added to a vial containing iPrOH (1 mL). (3S,4S)-4-(dimethylamino)pyrrolidin-3-ol (50 mg, 0.246 mmol) was added. The mixture was stirred at 110° C. for 16 h. The solvent was evaporated off under reduced pressure and the residue was purified by preparative SFC (Column DEAP, from 15% to 20% in 6 min) to afford the title product as a beige foam. HPLC (Condition 10)

## 252

$t_R=5.93$  min, UPLC-MS (Condition 3)  $t_R=0.81$  min,  $m/z=506.1$  [M+H]<sup>+</sup>; <sup>1</sup>H-NMR (400 MHz, DMSO-d<sub>6</sub>)  $\delta$  ppm 2.14 (s, 6H) 2.52-2.58 (m, 1H) 2.88 (dd, J=11.14, 5.28 Hz, 1H) 3.21 (dd, J=11.34, 5.86 Hz, 1H) 3.28 (dd, J=10.56, 5.86 Hz, 1H) 3.44 (dd, J=11.34, 7.00 Hz, 1H) 4.07 (quin, J=5.28 Hz, 1H) 5.07 (d, J=5.08 Hz, 1H) 7.35 (d, J=9.38 Hz, 2H) 7.85 (d, J=9.38 Hz, 3H) 8.09 (d, J=2.35 Hz, 1H) 8.52 (s, 1H) 8.61 (d, J=2.35 Hz, 1H) 8.78 (d, J=2.35 Hz, 1H) 10.19 (s, 1H).

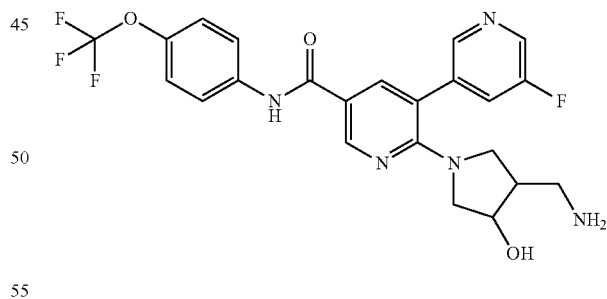
Stage 236.1 2-Chloro-5'-fluoro-N-(4-(trifluoromethoxy)phenyl)-[3,3'-bipyridine]-5-carboxamide



The title compound was prepared in an analogous fashion to that described in Stage 223.1 using 6-chloro-5-iodo-N-(4-(trifluoromethoxy)phenyl)nicotinamide and 3-fluoropyridine-5-boronic acid pinacol ester. The crude product was dissolved in DCM (20 mL) and treated with n-hexane. The resulting solid was filtered off, washed with n-hexane and dried to afford the title product as a beige solid. UPLC-MS (Condition 3)  $t_R=1.13$  min,  $m/z=412$  [M+H]<sup>+</sup>.

## Example 237

2-(3-(Aminomethyl)-4-hydroxypyrrolidin-1-yl)-5'-fluoro-N-(4-(trifluoromethoxy)phenyl)-[3,3'-bipyridine]-5-carboxamide



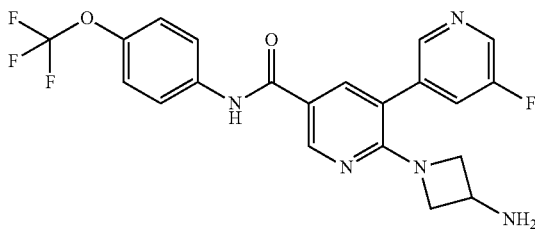
4-Boc-aminomethyl-1-N-Boc-pyrrolidine (71.5 mg, 0.226 mmol) was dissolved in DCM (1 mL) and treated with TFA (0.095 mL, 1.233 mmol). The mixture was stirred 20 h at RT. The solvent was evaporated under reduced pressure and the residue was dissolved in iPrOH (1 mL). 2-Chloro-5'-fluoro-N-(4-(trifluoromethoxy)phenyl)-[3,3'-bipyridine]-5-carboxamide (Stage 236.1, 90 mg, 0.205 mmol) and DIPEA (0.359 mL, 2.055 mmol) were added. The RM was then stirred 80° C. for 48 h. The RM was treated with sat. aq. Na<sub>2</sub>CO<sub>3</sub> (20 mL) and was extracted with EtOAc. The combined extracts were washed with brine (10 mL), dried over

## 253

Na<sub>2</sub>SO<sub>4</sub>, filtered and the filtrate was evaporated off under reduced pressure to give a crude product that was purified by preparative HPLC (Condition 14). TFA was removed using a PL-HCO<sub>3</sub> cartridge (StratoSpheres™) to afford the title product as a beige solid. HPLC (Condition 10) *t<sub>R</sub>*=5.617 min, UPLC-MS (Condition 3) *t<sub>R</sub>*=0.79 min, *m/z*=492.1 [M+H]<sup>+</sup>; <sup>1</sup>H-NMR (400 MHz, DMSO-*d*<sub>6</sub>) δ ppm 2.01-2.14 (m, 1H) 2.51-2.58 (m, 1H) 2.72 (dd, *J*=12.90, 6.30 Hz, 1H) 2.83 (dd, *J*=11.30, 4.30 Hz, 1H) 3.11-3.24 (m, 2H) 3.51-3.59 (m, 1H) 3.95 (q, *J*=5.08 Hz, 1H) 7.36 (d, *J*=8.99 Hz, 2H) 7.85 (m, *J*=9.40 Hz, 3H) 8.10 (d, *J*=2.35 Hz, 1H) 8.52 (s, 1H) 8.61 (d, *J*=2.74 Hz, 1H) 8.78 (dd, *J*=2.35, 1.17 Hz, 1H) 10.19 (s, 1H).

## Example 238

2-(3-Amino azetidin-1-yl)-5'-fluoro-N-(4-(trifluoromethoxy)phenyl)-[3,3'-bipyridine]-5-carboxamide



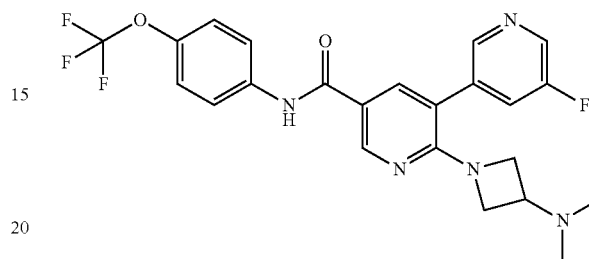
2-Chloro-5'-fluoro-N-(4-(trifluoromethoxy)phenyl)-[3,3'-bipyridine]-5-carboxamide (Stage 236.1, 70 mg, 0.160 mmol) and DIPEA (0.070 mL, 0.4 mmol) were added to a vial with iPrOH (1 mL). *tert*-Butyl azetidin-3-ylcarbamate (70.2 mg, 0.4 mmol) was added. The mixture was stirred at 110° C. for 5 h. *tert*-Butyl azetidin-3-ylcarbamate (35 mg) was added and the RM was stirred for further 5 h at 110° C. The RM was treated with citric acid 10% (10 mL) and extracted with EtOAc. The combined extracts were washed with an aq. sat. solution of NaHCO<sub>3</sub> (10 mL) and with brine (2×10 mL), dried over Na<sub>2</sub>SO<sub>4</sub>, filtered and the filtrate was evaporated off under reduced pressure to afford the crude product that was purified by flash chromatography (Silica gel column, 4 g, DCM/EtOH from 99:1 to 9:1). The resulting intermediate (33 mg, 0.054 mmol) was dissolved in DCM (1 mL). TFA (0.167 mL, 2.170 mmol) was added and the RM was stirred for 2 h at RT. The RM was treated sat. aq. Na<sub>2</sub>CO<sub>3</sub> (20 mL) and extracted with DCM. The combined extracts were washed with brine (20 mL), dried over Na<sub>2</sub>SO<sub>4</sub>, filtered and the filtrate was evaporated off under reduced pressure to give a crude product that was purified by preparative HPLC. Fractions containing product were combined and treated with 100 mg Na<sub>2</sub>CO<sub>3</sub> and the MeCN was removed. The aq. residue was extracted with DCM (3×10 mL) and the combined extracts were dried over Na<sub>2</sub>SO<sub>4</sub>, filtered and the filtrate was evaporated off under reduced pressure to afford the title product as a white foam. HPLC (Condition 10) *t<sub>R</sub>*=5.77 min, UPLC-MS (Condition 3) *t<sub>R</sub>*=0.81 min, *m/z*=448.2 [M+H]<sup>+</sup>; <sup>1</sup>H-NMR (400 MHz, DMSO-*d*<sub>6</sub>) δ ppm 3.36 (dd, *J*=8.60, 5.47 Hz, 2H) 3.56-3.68 (m, 1H) 3.84 (t, *J*=7.82 Hz, 2H) 7.35 (d, *J*=8.99 Hz, 2H) 7.85

## 254

(m, *J*=9.40 Hz, 3H) 8.06 (d, *J*=2.35 Hz, 1H) 8.53 (s, 1H) 8.62 (d, *J*=2.74 Hz, 1H) 8.78 (d, *J*=2.35 Hz, 1H) 10.20 (s, 1H).

## Example 239

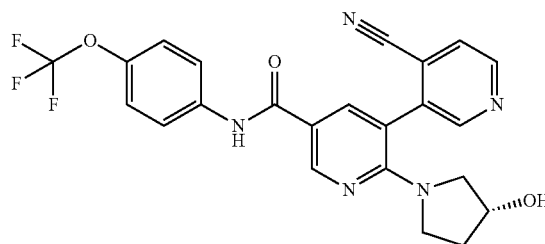
2-(3-(Dimethylamino)azetidin-1-yl)-5'-fluoro-N-(4-(trifluoromethoxy)phenyl)-[3,3'-bipyridine]-5-carboxamide



The title compound was prepared in an analogous fashion to that described in Example 236 using 2-chloro-5'-fluoro-N-(4-(trifluoromethoxy)phenyl)-[3,3'-bipyridine]-5-carboxamide (Stage 236.1) and N,N-dimethylazetidin-3-amine. The crude product was purified by preparative HPLC (Condition 14). Fractions containing product were combined, treated with sat. aq. Na<sub>2</sub>CO<sub>3</sub> and the MeCN was removed. The aq. phase was extracted with DCM and the combined organic layers were dried over Na<sub>2</sub>SO<sub>4</sub>, filtered and the filtrate was evaporated off under reduced pressure to afford the title product as white crystals. HPLC (Condition 10) *t<sub>R</sub>*=6.01 min, UPLC-MS (Condition 3) *t<sub>R</sub>*=0.82 min, *m/z*=476.1 [M+H]<sup>+</sup>; <sup>1</sup>H-NMR (400 MHz, DMSO-*d*<sub>6</sub>) δ ppm 1.99 (s, 6H) 2.95-3.04 (m, 1H) 3.53 (dd, *J*=9.19, 5.28 Hz, 2H) 3.69-3.77 (m, 2H) 7.36 (d, *J*=8.99 Hz, 2H) 7.87 (d, *J*=8.99 Hz, 3H) 8.08 (d, *J*=2.35 Hz, 1H) 8.54-8.57 (m, 1H) 8.63 (d, *J*=2.74 Hz, 1H) 8.79 (d, *J*=2.35 Hz, 1H) 10.23 (s, 1H).

## Example 240

(R)-4'-Cyano-2-(3-hydroxypyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)-[3,3'-bipyridine]-5-carboxamide



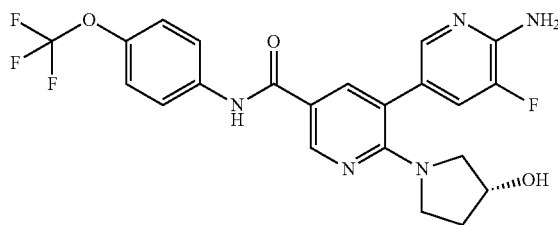
(R)-5-Bromo-6-(3-hydroxypyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 35.1, 100 mg, 0.224 mmol) was dissolved in DMF (1.5 mL). 4-Cyanopyridine-3-boronic acid pinacol ester (77 mg, 0.336 mmol), K<sub>2</sub>CO<sub>3</sub> (0.224 mL, 0.448 mmol) and Pd(PPh<sub>3</sub>)<sub>4</sub> (12.95 mg, 0.011 mmol) were added at RT. The vial was evacuated/purged with

## 255

argon and sealed. The light yellow solution was stirred at 130° C. for 4 h. The yellow reaction solution was diluted with EtOAc (50 mL) and washed with water (3×30 mL). the combined extracts were dried over Na<sub>2</sub>SO<sub>4</sub>, filtered, the solvent was evaporated off under reduced pressure to give a crude that was purified by flash chromatography (RediSep® Silica gel column, 24 g, DCM/MeOH 95:5). The fractions containing product were evaporated to dryness under reduced pressure and the residue was dissolved in hot MeOH (2 mL). The yellow solution was allowed to cool down to RT under stirring and the resulting suspension was stirred at RT for 1 h then filtered. The solid was washed with MeOH (1 mL) and dried to afford the title product as a white solid. HPLC (Condition 10) *t<sub>R</sub>*=5.91 min, UPLC-MS (Condition 3) *t<sub>R</sub>*=0.95 min, *m/z*=470 [M+H]<sup>+</sup>; <sup>1</sup>H-NMR (400 MHz, DMSO-*d*<sub>6</sub>) δ ppm 1.65-1.97 (m, 2H) 2.84 (d, *J*=10.95 Hz, 1H) 3.07-3.18 (m, 1H) 3.19-3.30 (m, 1H) 3.32-3.45 (m, 1H) 4.21 (br. s, 1H) 4.82-5.00 (m, 1H) 7.36 (d, *J*=8.99 Hz, 2H) 7.85 (d, *J*=8.99 Hz, 2H) 7.94-8.05 (m, 1H) 8.12 (d, *J*=6.26 Hz, 1H) 8.80-8.90 (m, 2H) 9.03 (s, 1H) 10.21 (s, 1H).

## Example 241

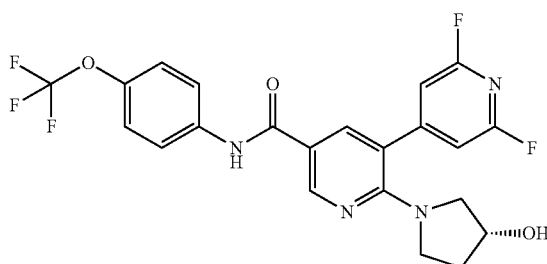
(R)-6'-Amino-5'-fluoro-2-(3-hydroxypyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)-[3,3'-bipyridine]-5-carboxamide



The title compound was prepared in an analogous fashion to that described in Example 169 using (R)-5-bromo-6-(3-hydroxypyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl) nicotinamide (Stage 35.1) and 3-fluoro-5-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)pyridin-2-amine to afford a white amorphous powder. HPLC (Condition 4) *t<sub>R</sub>*=4.37 min, UPLC-MS (Condition 3) *t<sub>R</sub>*=0.91 min, *m/z*=478.1 [M+H]<sup>+</sup>; <sup>1</sup>H-NMR (400 MHz, DMSO-*d*<sub>6</sub>) δ ppm 1.66-1.89 (m, 2H) 2.94 (d, *J*=11.34 Hz, 1H) 3.18-3.28 (m, 2H) 3.34-3.47 (m, 1H) 4.19 (br. s, 1H) 4.83 (d, *J*=3.13 Hz, 1H) 6.32 (s, 2H) 7.32 (d, *J*=8.99 Hz, 2H) 7.40 (d, *J*=11.73 Hz, 1H) 7.77 (s, 1H) 7.83 (d, *J*=8.99 Hz, 2H) 7.93 (m, *J*=2.30, 1.20 Hz, 1H) 8.64-8.72 (m, 1H) 10.11 (s, 1H).

## Example 242

(R)-2',6'-Difluoro-2-(3-hydroxypyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl)-[3,4'-bipyridine]-5-carboxamide

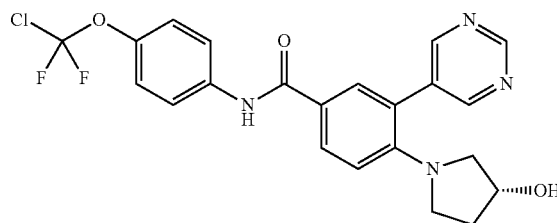


## 256

The title compound was prepared in an analogous fashion to that described in Example 169 using (R)-5-bromo-6-(3-hydroxypyrrolidin-1-yl)-N-(4-(trifluoromethoxy)phenyl) nicotinamide (Stage 35.1) and 2,6-difluoropyridin-4-ylboronic acid to afford a white amorphous powder. HPLC (Condition 4) *t<sub>R</sub>*=5.67 min, UPLC-MS (Condition 3) *t<sub>R</sub>*=1.10 min, *m/z*=481.1 [M+H]<sup>+</sup>; <sup>1</sup>H-NMR (400 MHz, DMSO-*d*<sub>6</sub>) δ ppm 1.70-1.80 (m, 1H) 1.87 (m, *J*=9.00 Hz, 1H) 2.86 (d, *J*=11.34 Hz, 1H) 3.18-3.29 (m, 2H) 3.47 (m, *J*=7.00 Hz, 1H) 4.22 (br. s, 1H) 4.87 (d, *J*=3.52 Hz, 1H) 7.23 (s, 2H) 7.34 (d, *J*=9.38 Hz, 2H) 7.78-7.89 (m, 2H) 8.13 (d, *J*=2.35 Hz, 1H) 8.78 (d, *J*=2.35 Hz, 1H) 10.18 (s, 1H).

## Example 243

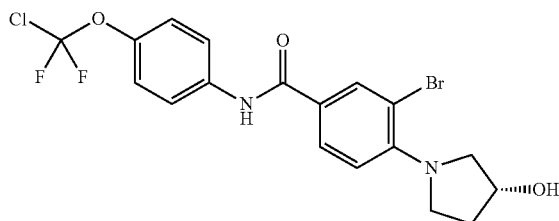
(R)-N-(4-(Chlorodifluoromethoxy)phenyl)-4-(3-hydroxypyrrolidin-1-yl)-3-(pyrimidin-5-yl)benzamide



(R)-3-Bromo-N-(4-(chlorodifluoromethoxy)phenyl)-4-(3-hydroxypyrrolidin-1-yl)benzamide (Stage 243.1, 80 mg, 0.173 mmol), pyrimidin-5-ylboronic acid (42.9 mg, 0.347 mmol), Pd(PPh<sub>3</sub>)<sub>2</sub>Cl<sub>2</sub> (12.16 mg, 0.017 mmol) and Na<sub>2</sub>CO<sub>3</sub> (73.5 mg, 0.693 mmol) were added to a MW vial and treated with a mixture of DME (735 μL), water (210 μL) and EtOH (105 μL). The vial was sealed, evacuated/purged with argon and subjected to MW irradiation at 125° C. for 15 min, diluted with DCM (2 mL), treated with Si-Thiol (Silicycle, 1.43 mmol/g, 72.2 mg, 0.104 mmol). The RM was centrifuged, the supernatant was filtered and the solvent was evaporated off under reduced pressure to give a residue which was purified by flash chromatography (RediSep® Silica gel column, 12 g, DCM/MeOH+1% NH<sub>4</sub>OH from 1% to 10% MeOH+1% NH<sub>4</sub>OH). Product was further purified by preparative SFC (Column DEAP, isocratic 6% in 6 min) to yield the title product as a white solid. UPLC-MS (Condition 3) *t<sub>R</sub>*=1.01 min, *m/z*=461.1 [M+H]<sup>+</sup>, *m/z*=459.1 [M-H]<sup>-</sup>; <sup>1</sup>H-NMR (400 MHz, DMSO-*d*<sub>6</sub>) δ ppm 1.66-1.81 (m, 1H) 1.82-1.94 (m, 1H) 2.68 (d, *J*=9.66 Hz, 1H) 2.98-3.10 (m, 2H) 3.18-3.27 (m, 1H) 4.17-4.26 (m, 1H) 4.89 (d, *J*=3.55 Hz, 1H) 6.99 (d, *J*=8.80 Hz, 1H) 7.33 (d, *J*=9.17 Hz, 2H) 7.82-7.90 (m, 3H) 7.95 (dd, *J*=8.80, 2.20 Hz, 1H) 8.87 (s, 2H) 9.17 (s, 1H) 10.12 (s, 1H).

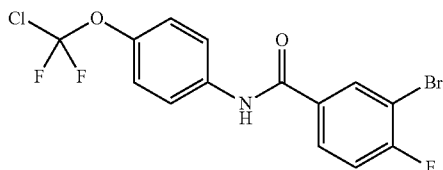
## 257

Stage 243.1 (R)-3-Bromo-N-(4-(chlorodifluoromethoxy)phenyl)-4-(3-hydroxypyrrolidin-1-yl)benzamide



A mixture of 3-bromo-N-(4-(chlorodifluoromethoxy)phenyl)-4-fluorobenzamide (1 g, 2.53 mmol), (R)-pyrrolidin-3-ol (0.331 g, 3.80 mmol) in TEA (0.706 mL, 5.07 mmol) and DMSO (2.53 mL) was stirred at 90° C. for 20 h. The RM was treated with 0.5 M HCl (50 mL) and extracted with EtOAc. The combined extracts were washed with 0.5 M HCl, sat. aq. NaHCO<sub>3</sub> and brine, and dried over Na<sub>2</sub>SO<sub>4</sub>. The solvent was evaporated off under reduced pressure to give the crude product which was purified by flash chromatography (RediSep® Silica gel column, 40 g, cyclohexane/EtOAc, from 1% to 4.5% EtOAc). The residue was suspended in cyclohexane. The solid was filtered-off and dried to yield the title product as a white amorphous solid. UPLC-MS (Condition 3)  $t_R$ =1.15 min,  $m/z$ =462.9 [M+H]<sup>+</sup>,  $m/z$ =460.9 [M-H]<sup>-</sup>; <sup>1</sup>H-NMR (400 MHz, DMSO-d<sub>6</sub>)  $\delta$  ppm 1.81-1.90 (m, 1H) 1.92-2.03 (m, 1H) 3.27 (dd, J=10.39, 1.10 Hz, 1H) 3.36-3.44 (m, 1H) 3.62-3.71 (m, 1H) 3.81 (dd, J=10.45, 4.71 Hz, 1H) 4.32-4.40 (m, 1H) 4.99 (d, J=3.42 Hz, 1H) 6.93 (d, J=8.80 Hz, 1H) 7.33 (d, J=9.05 Hz, 2H) 7.82-7.91 (m, 3H) 8.14 (d, J=2.20 Hz, 1H) 10.21 (s, 1H).

Stage 243.2 3-Bromo-N-(4-(chlorodifluoromethoxy)phenyl)-4-fluorobenzamide



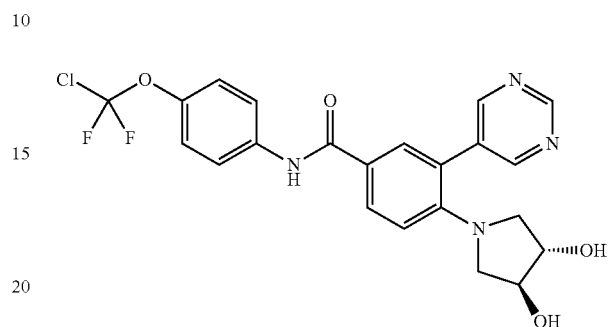
The title compound was prepared in an analogous fashion to that described in Stage 1.2 using 3-bromo-4-fluorobenzoic acid and 4-(chlorodifluoromethoxy)aniline to afford an off-white solid. UPLC-MS (Condition 3)  $t_R$ =1.25 min,  $m/z$ =394.0 [M+H]<sup>+</sup>,  $m/z$ =391.9 [M-H]<sup>-</sup>; <sup>1</sup>H-NMR (400 MHz, DMSO-d<sub>6</sub>)  $\delta$  ppm 7.37 (d, J=9.17 Hz, 2H) 7.57 (t,

## 258

J=8.68 Hz, 1H) 7.84-7.91 (m, 2H) 8.03 (ddd, J=8.62, 4.83, 2.32 Hz, 1H) 8.32 (dd, J=6.60, 2.20 Hz, 1H) 10.52 (s, 1H).

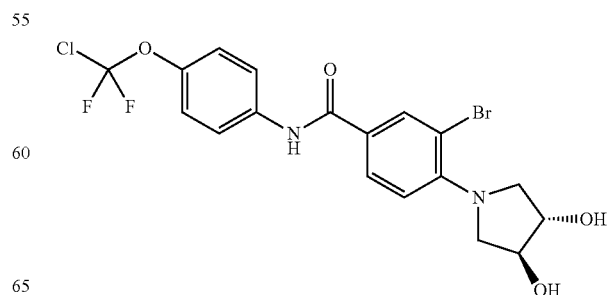
## Example 244

N-(4-(Chlorodifluoromethoxy)phenyl)-4-((3S,4S)-3,4-dihydroxypyrrolidin-1-yl)-3-(pyrimidin-5-yl)benzamide



3-Bromo-N-(4-(chlorodifluoromethoxy)phenyl)-4-((3S, 4S)-3,4-dihydroxypyrrolidin-1-yl)benzamide (Stage 244.1, 80 mg, 0.167 mmol), pyrimidin-5-ylboronic acid (41.5 mg, 0.335 mmol), Pd(PPh<sub>3</sub>)<sub>2</sub>Cl<sub>2</sub> (11.76 mg, 0.017 mmol) and Na<sub>2</sub>CO<sub>3</sub> (71.0 mg, 0.670 mmol) were added to a MW vial and treated with a mixture of DME (710  $\mu$ L), water (203  $\mu$ L) and EtOH (101  $\mu$ L). The vial was sealed, evacuated/purged with argon and subjected to MW irradiation at 125° C. for 10 min, diluted with MeOH (1 mL) and DCM (2 mL), treated with Si-Thiol (Silicycle, 1.44 mmol/g, 69.8 mg, 0.1 mmol). The solvent was evaporated off under reduced pressure to give a crude product that was purified by flash chromatography (RediSep® Silica gel column, 12 g, DCM/(MeOH-1% NH<sub>4</sub>OH), from 2% to 12% (MeOH-1% NH<sub>4</sub>OH). Product was further purified by preparative SFC (Column DEAP, from 25% to 30% in 10 min) to yield the title product as a white solid. UPLC-MS (Condition 3)  $t_R$ =0.90 min,  $m/z$ =476.9 [M+H]<sup>+</sup>,  $m/z$ =521.0 [M+ formic acid-H]<sup>-</sup>; <sup>1</sup>H-NMR (400 MHz, DMSO-d<sub>6</sub>)  $\delta$  ppm 2.75 (d, J=10.39 Hz, 2H) 3.27 (dd, J=10.33, 3.61 Hz, 2H) 3.88 (br. s, 2H) 5.09 (d, J=3.18 Hz, 2H) 6.97 (d, J=8.93 Hz, 1H) 7.33 (d, J=9.05 Hz, 2H) 7.82-7.90 (m, 3H) 7.94 (dd, J=8.80, 2.20 Hz, 1H) 8.86 (s, 2H) 9.17 (s, 1H) 10.11 (s, 1H).

Stage 244.1 3-Bromo-N-(4-(chlorodifluoromethoxy)phenyl)-4-((3S,4S)-3,4-dihydroxypyrrolidin-1-yl)benzamide

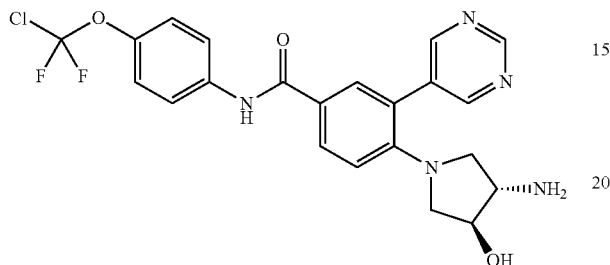


## 259

The title compound was prepared in an analogous fashion to that described in Stage 243.1 (20 h at 90° C.+3 h at 105° C.) using 3-bromo-N-(4-(chlorodifluoromethoxy)phenyl)-4-fluorobenzamide and (3S,4S)-pyrrolidine-3,4-diol to afford a white amorphous solid. UPLC-MS (Condition 3)  $t_R$ =1.01 min,  $m/z$ =476.8 [M+H]<sup>+</sup>.

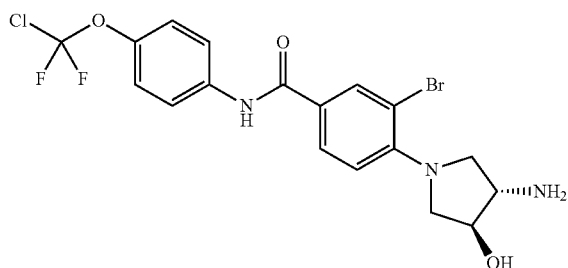
## Example 245

4-((3S,4S)-3-Amino-4-hydroxypyrrolidin-1-yl)-N-(4-(chlorodifluoromethoxy)phenyl)-3-(pyrimidin-5-yl)benzamide



4-((3S,4S)-3-amino-4-hydroxypyrrolidin-1-yl)-3-bromo-N-(4-(chlorodifluoromethoxy)phenyl)benzamide (Stage 245.1, 60 mg, 0.121 mmol), 5-pyrimidineboronic acid (22.46 mg, 0.181 mmol) and Na<sub>2</sub>CO<sub>3</sub> aq. (0.181 mL, 0.362 mmol) were added to a vial containing DME (1.5 mL) under argon atmosphere. PdCl<sub>2</sub>(dppf)-(CH<sub>2</sub>Cl<sub>2</sub>) (5.92 mg, 7.25 μmol) was added. The RM was stirred at 80° C. for 2 h, then filtered through Hyflo® and the solvent was evaporated off under reduced pressure to give the crude product which was purified by preparative HPLC (Condition 14). Fractions containing the product were combined, treated with sat. aq. Na<sub>2</sub>CO<sub>3</sub> and the MeCN was removed. The aq. residue was extracted with DCM and the combined extracts were dried over Na<sub>2</sub>SO<sub>4</sub>, filtered and the filtrate was evaporated off under reduced pressure to give a residue that was suspended in DCM/n-hexane. The obtained solid was filtered off and washed with n-hexane then purified by SFC. The residue diluted with sat. aq. Na<sub>2</sub>CO<sub>3</sub> (20 mL) and DCM (20 mL). Aq. phase was extracted with DCM (2×10 mL) and with EtOAc (3×10 mL). The combined extracts were dried over Na<sub>2</sub>SO<sub>4</sub> and the solvent was evaporated off under reduced pressure to afford the title product as a beige solid. HPLC (Condition 10)  $t_R$ =5.77 min, UPLC-MS (Condition 3)  $t_R$ =0.79 min,  $m/z$ =476.1/478.2 [M+H]<sup>+</sup>; <sup>1</sup>H-NMR (400 MHz, DMSO-d<sub>6</sub>) δ ppm 2.65-2.73 (m, 2H) 3.09-3.15 (m, 1H) 3.21-3.30 (m, 2H) 3.71-3.79 (m, 1H) 5.00 (d, J=3.50 Hz, 1H) 6.95 (d, J=8.99 Hz, 1H) 7.34 (d, J=8.20 Hz, 2H) 7.83-7.90 (m, 3H) 7.94 (dd, J=8.60, 2.30 Hz, 1H) 8.86 (d, J=0.78 Hz, 2H) 9.17 (d, J=1.17 Hz, 1H) 10.10 (s, 1H).

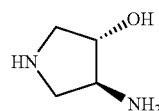
Stage 245.1 4-((3S,4S)-3-Amino-4-hydroxypyrrolidin-1-yl)-3-bromo-N-(4-(chlorodifluoromethoxy)phenyl)benzamide



## 260

3-Bromo-N-(4-(chlorodifluoromethoxy)phenyl)-4-fluorobenzamide (240 mg, 0.596 mmol) and TEA (0.332 mL, 2.384 mmol) were added to a vial containing DMSO (0.5 mL). (3S,4S)-4-aminopyrrolidin-3-ol dihydrochloride (Stage 245.2, 128 mg, 0.715 mmol) was added. The RM was stirred at 100° C. for 40 h. The RM was treated with sat. aq. Na<sub>2</sub>CO<sub>3</sub> (50 mL) and was extracted with EtOAc. The combined extracts were washed with water (30 mL) and brine (30 mL), dried over Na<sub>2</sub>SO<sub>4</sub>, filtered and the filtrate was evaporated off under reduced pressure to give a crude product that was purified by flash chromatography (from 100% EtOAc to EtOAc/EtOH/NH<sub>3</sub> aq. 90:9:1) to afford the title product as a beige solid. HPLC (Condition 10)  $t_R$ =6.08 min, UPLC-MS (Condition 3)  $t_R$ =0.82 min,  $m/z$ =476.1/478.1 [M+H]<sup>+</sup>.

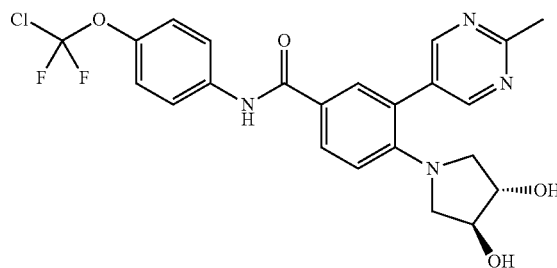
Stage 245.2 (3S,4S)-4-Aminopyrrolidin-3-ol dihydrochloride



(3S,4S)-tert-Butyl 3-amino-4-hydroxypyrrolidine-1-carboxylate (0.3 g, 1.439 mmol) in 1.25 M HCl 1.25 M in EtOH (11.51 mL, 14.39 mmol) was stirred for 24 h at RT. The white suspension was evaporated to dryness under reduced pressure and the residue was suspended in MeOH (10 mL) and evaporated again to afford the title compound.

## Example 246

N-(4-(Chlorodifluoromethoxy)phenyl)-4-((3S,4S)-3,4-dihydroxypyrrolidin-1-yl)-3-(2-methylpyrimidin-5-yl)benzamide

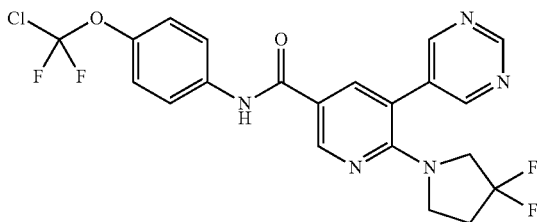


The title compound was prepared in an analogous fashion to that described in Example 244 (only SFC purification) using 3-bromo-N-(4-(chlorodifluoromethoxy)phenyl)-4-((3S,4S)-3,4-dihydroxypyrrolidin-1-yl)benzamide (Stage 244.1) and 2-methylpyrimidin-5-ylboronic to afford a brown solid. UPLC-MS (Condition 3)  $t_R$ =0.91 min,  $m/z$ =491.1 [M+H]<sup>+</sup>,  $m/z$ =535.1 [M+ formic acid-H]; <sup>1</sup>H-NMR (400 MHz, DMSO-d<sub>6</sub>) δ ppm 2.69 (s, 3H) 2.75 (d, J=10.39 Hz, 2H) 3.27 (dd, J=10.33, 3.73 Hz, 2H) 3.88 (br. s, 2H) 5.07 (d, J=3.30 Hz, 2H) 6.94 (d, J=8.80 Hz, 1H) 7.33 (d, J=9.05 Hz, 2H) 7.82 (d, J=2.32 Hz, 1H) 7.84-7.90 (m, 2H) 7.92 (dd, J=8.80, 2.32 Hz, 1H) 8.72 (s, 2H) 10.09 (s, 1H).

## 261

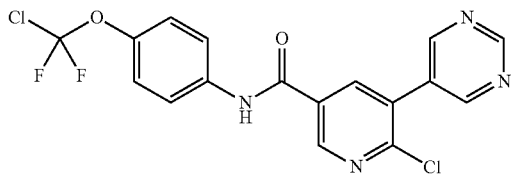
## Example 247

N-(4-(Chlorodifluoromethoxy)phenyl)-6-(3,3-difluoropyrrolidin-1-yl)-5-(pyrimidin-5-yl)nicotinamide



The title compound was prepared in an analogous fashion to that described in Example 224 using 6-chloro-N-(4-(chlorodifluoromethoxy)phenyl)-5-(pyrimidin-5-yl)nicotinamide (Stage 247.1) and 3,3-difluoropyrrolidine hydrochloride (no extraction with citric acid). After purification by flash chromatography on Silica gel, the residue was suspended in  $i\text{Pr}_2\text{O}$  (10 mL) and stirred for 30 min. Crystals were filtrated off, washed with  $i\text{Pr}_2\text{O}$  (10 mL) and dried to afford the title product as a white solid. HPLC (Condition 10)  $t_R=7.198$  min, UPLC-MS (Condition 3)  $t_R=1.12$  min,  $m/z=482$   $[\text{M}+\text{H}]^+$ ;  $^1\text{H}$ -NMR (400 MHz,  $\text{DMSO}-d_6$ )  $\delta$  ppm 2.39 (spt,  $J=7.14$  Hz, 2H) 3.37 (t,  $J=7.23$  Hz, 2H) 3.62 (t,  $J=12.90$  Hz, 2H) 7.36 (d,  $J=8.21$  Hz, 2H) 7.87 (d,  $J=8.99$  Hz, 2H) 8.15 (s, 1H) 8.82 (s, 1H) 8.94 (s, 2H) 9.23 (s, 1H) 10.28 (s, 1H).

Stage 247.1 6-Chloro-N-(4-(chlorodifluoromethoxy)phenyl)-5-(pyrimidin-5-yl)nicotinamide

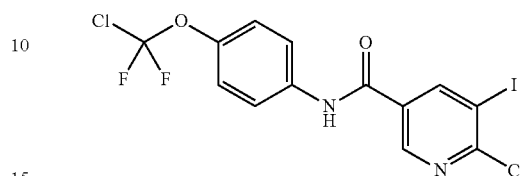


6-Chloro-N-(4-(chlorodifluoromethoxy)phenyl)-5-iodonicotinamide (Stage 247.2, 8 g, 17.43 mmol), pyrimidine-5-boronic acid (4.55 g, 34.9 mmol),  $\text{PdCl}_2(\text{dppf})$  (0.638 g, 0.871 mmol),  $\text{Na}_2\text{CO}_3$  (26.1 mL of 2 M, 52.3 mmol), and DME (110 mL) were added to a vial, which was sealed, evacuated/purged with argon and the RM was stirred at  $90^\circ\text{C}$ . for 20 h. The RM was dissolved in EtOAc (200 mL), washed with water, dried over  $\text{Na}_2\text{SO}_4$  and the solvent was evaporated off under reduced pressure. The residue was purified by flash chromatography (Silica gel column, 750 g, EtOAc/n-hexane 1:1) and recrystallized from EtOAc/ $i\text{Pr}_2\text{O}$  to give the title product as a pink solid. HPLC (Condition 10)  $t_R=6.77$  min, UPLC-MS (Condition 3)  $t_R=1.05$  min,  $m/z=409.0/411.0$   $[\text{M}-\text{H}]^-$ ;  $^1\text{H}$ -NMR (400 MHz,  $\text{DMSO}-d_6$ )  $\delta$  ppm 6.59 (d,

## 262

$J=8.60$  Hz, 2H) 7.07 (d,  $J=8.99$  Hz, 2H) 7.75 (d,  $J=1.95$  Hz, 1H) 8.18-8.24 (m, 1H) 8.28 (s, 2H) 8.50 (s, 1H) 9.88 (s, 1H).

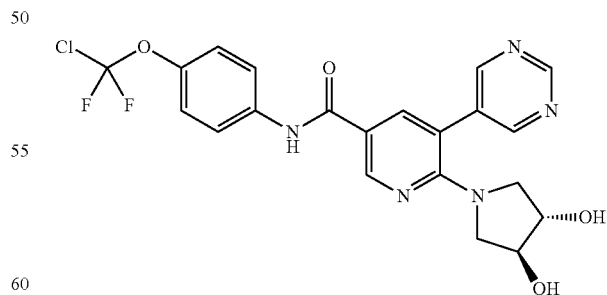
Stage 247.2 6-Chloro-N-(4-(chlorodifluoromethoxy)phenyl)-5-iodonicotinamide



6-Chloro-5-iodo-3-pyridinecarboxylic acid (18 g, 62.2 mmol) was suspended in toluene (125 mL). DMF (1.446 mL, 18.67 mmol) and  $\text{SOCl}_2$  (13.63 mL, 187 mmol) were added at RT. The RM was stirred at  $80^\circ\text{C}$ . for 1 h, cooled to RT then the solvent was evaporated off under reduced pressure to give a residue that was dissolved in THF (125 mL) and cooled to  $-15^\circ\text{C}$ . DIPEA (21.74 mL, 124 mmol) was added at  $-15^\circ\text{C}$ ., and the cold mixture was treated dropwise with a solution of 4-(chlorodifluoromethoxy)aniline in THF (125 mL) over 12 min. The resulting fine orange suspension was stirred for 1 h at RT. The solvent was evaporated off under reduced pressure and the residue was dissolved in TBME (500 mL), and sequentially washed with 1N HCl (2x150 mL), sat. aq.  $\text{NaHCO}_3$  solution (2x150 mL) and brine (2x150 mL). The aq. phases were extracted with TBME (400 mL). Combined organic phases were dried over  $\text{Na}_2\text{SO}_4$ , filtered and concentrated under reduced pressure until crystallization began (around 100 mL). n-Heptane (800 mL) was then added with stirring and the light yellow suspension was stirred at RT for 30 min. The crystalline product was filtrated, washed with n-heptane (200 mL) and dried to afford the title product as a beige solid. LC-MS (Condition 3)  $t_R$  1.25 min, 459.0/460.7/462.1  $[\text{M}+\text{H}]^+$ .

## Example 248

N-(4-(Chlorodifluoromethoxy)phenyl)-6-((3S,4S)-3,4-dihydroxypyrrolidin-1-yl)-5-(pyrimidin-5-yl)nicotinamide

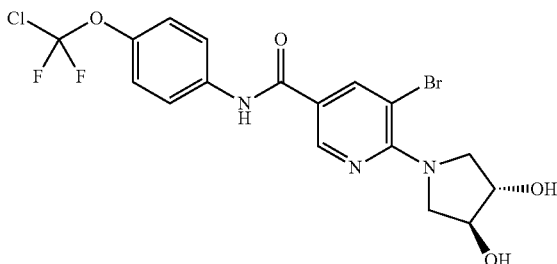


The title compound was prepared in an analogous fashion to that described in Example 244 using 3-bromo-N-(4-(chlorodifluoromethoxy)phenyl)-4-((3S,4S)-3,4-dihydroxypyrrolidin-1-yl)benzamide (Stage 244.1) and pyrimidin-5-ylboronic acid to afford an off-white solid. UPLC-MS (Condition

## 263

3)  $t_R=0.87$  min,  $m/z=478.0$   $[M+H]^+$ ,  $m/z=476.0$   $[M-H]^-$ ;  $^1H$ -NMR (400 MHz, DMSO- $d_6$ )  $\delta$  ppm 2.95 (d,  $J=11.49$  Hz, 2H) 3.42 (dd,  $J=11.43, 3.36$  Hz, 2H) 3.88 (br. s, 2H) 5.09 (d,  $J=3.30$  Hz, 2H) 7.35 (d,  $J=9.05$  Hz, 2H) 7.82-7.91 (m, 2H) 8.11 (d,  $J=2.32$  Hz, 1H) 8.79 (d,  $J=2.32$  Hz, 1H) 8.89 (s, 2H) 9.21 (s, 1H) 10.20 (s, 1H).

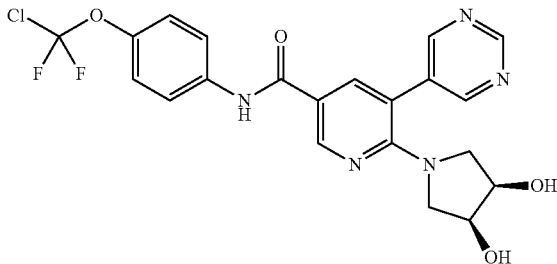
Stage 248.1 5-Bromo-N-(4-(chlorodifluoromethoxy)phenyl)-6-(3S,4S)-3,4-dihydroxypyrrolidin-1-yl)nicotinamide



A suspension of 5-bromo-6-chloro-N-(4-(chlorodifluoromethoxy)phenyl)nicotinamide (Stage 169.2, 1 g, 2.427 mmol) and (3S,4S)-pyrrolidine-3,4-diol (0.3 g, 2.91 mmol) in a mixture of DIPEA (1.272 mL, 7.28 mmol) and iPrOH (3.24 mL) was subjected to MW irradiation at  $140^\circ$  C. for 1 h. The RM was treated with 0.5 M HCl (40 mL) and extracted with EtOAc. The combined extracts were washed with water, sat. aq.  $NaHCO_3$  and brine, dried over  $Na_2SO_4$  and the solvent was evaporated off under reduced pressure to give a residue that was suspended in a mixture of cyclohexane EtOAc. The resulting solid was filtered-off, washed with cyclohexane and dried to afford the title product as an off-white solid. UPLC-MS (Condition 3)  $t_R=0.98$  min,  $m/z=477.9$   $[M+H]^+$ ,  $m/z=475.8$   $[M-H]^-$ ;  $^1H$ -NMR (400 MHz, DMSO- $d_6$ )  $\delta$  ppm 3.55 (d,  $J=11.13$  Hz, 2H) 3.91-4.09 (m, 4H) 5.18 (d,  $J=2.81$  Hz, 2H) 7.34 (d,  $J=9.05$  Hz, 2H) 7.80-7.93 (m, 2H) 8.34 (d,  $J=1.96$  Hz, 1H) 8.67 (d,  $J=1.96$  Hz, 1H) 10.24 (s, 1H).

## Example 249

N-(4-(Chlorodifluoromethoxy)phenyl)-6-(cis-3,4-dihydroxypyrrolidin-1-yl)-5-(pyrimidin-5-yl)nicotinamide

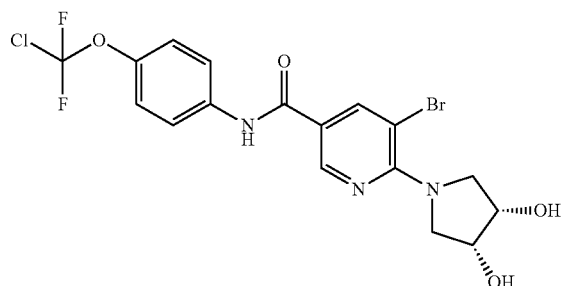


The title compound was prepared in an analogous fashion to that described in Example 244 using 5-bromo-N-(4-(chlorodifluoromethoxy)phenyl)-6-(cis-3,4-dihydroxypyrrolidin-

## 264

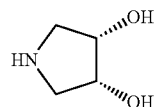
1-yl)nicotinamide (Stage 249.1) and pyrimidin-5-ylboronic acid to afford a white solid. UPLC-MS (Condition 3)  $t_R=0.87$  min,  $m/z=478.1$   $[M+H]^+$ ,  $m/z=476.1$   $[M-H]^-$ ;  $^1H$ -NMR (400 MHz, DMSO- $d_6$ )  $\delta$  ppm 3.05 (dd,  $J=11.00, 4.40$  Hz, 2H) 3.26 (dd,  $J=10.64, 5.26$  Hz, 2H) 3.94-4.02 (m, 2H) 4.88 (d,  $J=4.65$  Hz, 2H) 7.34 (d,  $J=9.05$  Hz, 2H) 7.81-7.90 (m, 2H) 8.10 (d,  $J=2.20$  Hz, 1H) 8.79 (d,  $J=2.20$  Hz, 1H) 8.88 (s, 2H) 9.20 (s, 1H) 10.18 (s, 1H).

Stage 249.1 5-Bromo-N-(4-(chlorodifluoromethoxy)phenyl)-6-(cis-3,4-dihydroxypyrrolidin-1-yl)nicotinamide



The title compound was prepared in an analogous fashion to that described in Stage 71.1 using 5-bromo-6-chloro-N-(4-(chlorodifluoromethoxy)phenyl)nicotinamide (Stage 169.2) and cis-pyrrolidine-3,4-diol (Stage 249.2). After purification by flash chromatography on Silica gel, the oily residue was taken-up in a toluene/MeOH mixture then evaporated to dryness under reduced pressure and dried to yield the title product as a white amorphous solid. UPLC-MS (Condition 3)  $t_R=1.0$  min,  $m/z=477.8$ -479.9  $[M+H]^+$ ,  $m/z=475.8$ -477.9  $[M-H]^-$ .

Stage 249.2 cis-Pyrrolidine-3,4-diol



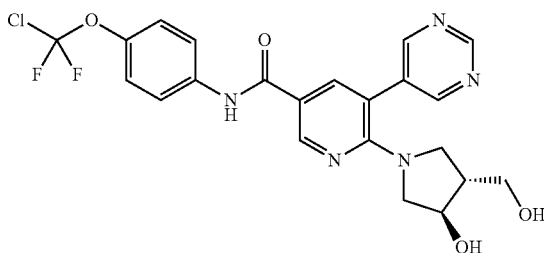
To a solution of benzyl 2,5-dihydro-1H-pyrrole-1-carboxylate (5 g, 22.14 mmol) in THF (33 mL) and water (8.3 mL) were added N-methylmorpholine-N-oxide (2.85 g, 24.36 mmol) and osmium tetroxide, 2.5% wt solution in 2-methyl-2-propanol (3.34 mL, 0.266 mmol). The RM was stirred at RT for 16 h. The solvent was evaporated off under reduced pressure and the residue was treated with EtOAc (100 mL), was washed with aq.  $Na_2SO_3$  (1 g in 30 mL water), aq.  $NaHCO_3$ , and brine. The combined aq. phases were back-extracted with EtOAc (30 mL) and the combined organic phases were dried over  $Na_2SO_4$  and evaporated to dryness under reduced pressure to give the crude product which was purified by flash chromatography (Biotage SNAP Silica gel column, 100 g, DCM/MeOH, from 2% to 7% MeOH). To a solution of part of previous product (2.373 g, 10 mmol) in MeOH (50 mL) was added NP Pd(0)EnCat<sup>TM</sup> 30, 0.4 mmol

## 265

Pd/g (1.5 g, 0.6 mmol). The vial was evacuated/purged with argon and the mixture was stirred at RT for 16 h under a hydrogen atmosphere. The catalyst was filtered off and the solvent was evaporated off under reduced pressure to afford the title product as a dark red oil, which was used in the next step without further purification. ESI+/(120-1200);  $m/z=104.1$   $[M+H]^+$ .

## Example 250

N-(4-(Chlorodifluoromethoxy)phenyl)-6-(trans-3-hydroxy-4-(hydroxymethyl)pyrrolidin-1-yl)-5-(pyrimidin-5-yl)nicotinamide



## 266

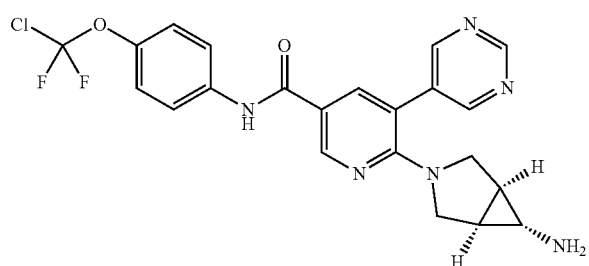
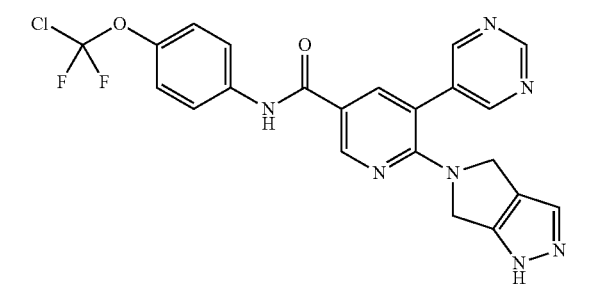
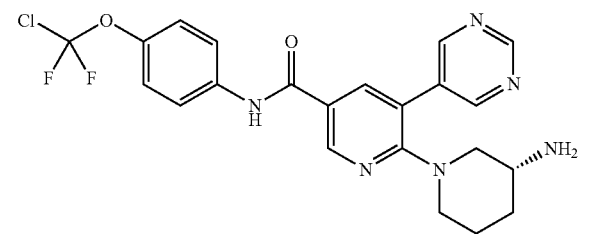
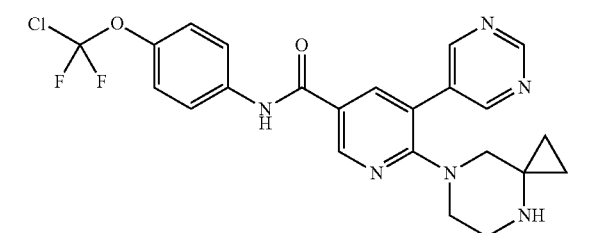
A suspension of 6-chloro-N-(4-(chlorodifluoromethoxy)phenyl)-5-(pyrimidin-5-yl)nicotinamide (Stage 247.1, 80 mg, 0.195 mmol), trans-4-(hydroxymethyl)pyrrolidin-3-ol (+/-), hydrochloride (80 mg, 0.521 mmol) in a mixture of DIPEA (136  $\mu$ L, 0.778 mmol) and iPrOH (389  $\mu$ L) was subjected to MW irradiation at 140° C. for 1.5 h. The RM was treated with water (10 mL) and extracted with EtOAc. The combined extracts were washed with sat.  $\text{NaHCO}_3$  and brine, dried over  $\text{Na}_2\text{SO}_4$  and the solvent was evaporated off under reduced pressure to give a crude product that was purified by preparative SFC (Column DEAP, from 22% to 27% in 10 min) to yield the title product as a white solid. UPLC-MS (Condition 3)  $t_R=0.86$  min,  $m/z=492.1$   $[M+H]^+$ ,  $m/z=536.2$   $[M+\text{formic acid-H}]$ ;  $^1\text{H-NMR}$  (400 MHz,  $\text{DMSO-d}_6$ )  $\delta$  ppm 2.04-2.14 (m, 1H) 2.89 (dd,  $J=11.13, 3.91$  Hz, 1H) 3.10 (dd,  $J=11.13, 5.26$  Hz, 1H) 3.20-3.29 (m, 2H) 3.34-3.48 (m, 2H) 3.92-4.01 (m, 1H) 4.63 (t,  $J=5.26$  Hz, 1H) 4.98 (d,  $J=4.40$  Hz, 1H) 7.35 (d,  $J=9.05$  Hz, 2H) 7.81-7.90 (m, 2H) 8.10 (d,  $J=2.45$  Hz, 1H) 8.80 (d,  $J=2.32$  Hz, 1H) 8.90 (s, 2H) 9.20 (s, 1H) 10.19 (s, 1H).

## Example 251-265

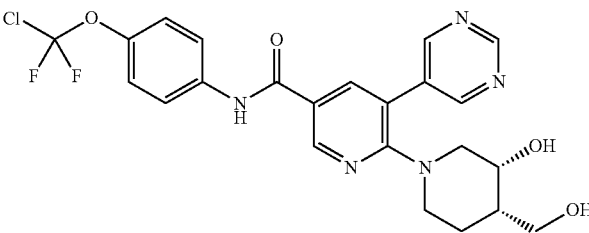
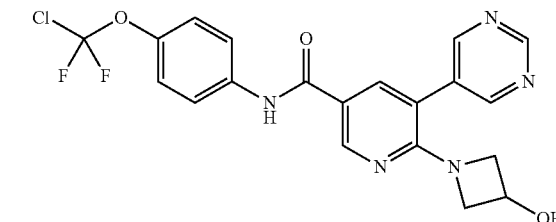
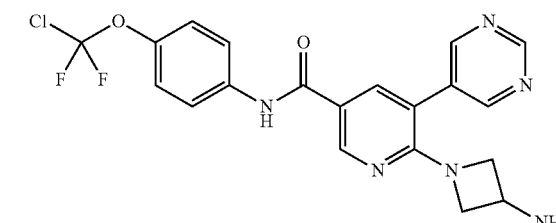
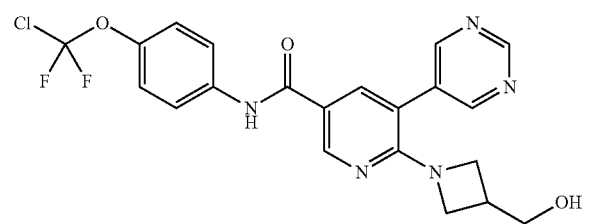
The following examples were prepared in an analogous fashion to that described in the Example using the Stage as indicated.

Ex.	Structure/Name	Example/Stage and starting material Analytics
251	<p>N-(4-(chlorodifluoromethoxy)phenyl)-6-((3S,4S)-3-(dimethylamino)-4-hydroxypyrrolidin-1-yl)-5-(pyrimidin-5-yl)nicotinamide</p>	<p>225/247.1 and (3S,4S)-4-(dimethylamino)pyrrolidin-3-ol HPLC (Condition 10) <math>t_R = 5.75</math> min, UPLC-MS (Condition 3) <math>t_R = 0.77</math> min, <math>m/z = 505.1/507.0</math> <math>[M+H]^+</math>; <math>^1\text{H-NMR}</math> (400 MHz, <math>\text{DMSO-d}_6</math>) <math>\delta</math> ppm 2.16 (br. s, 6 H) 2.50 (d, <math>J = 0.78</math> Hz, 1 H) 2.86 (dd, <math>J = 10.75, 5.28</math> Hz, 1 H) 3.15-3.31 (m, 2 H) 3.38-3.56 (m, 1 H) 4.10 (br. s, 1 H) 7.35 (d, <math>J = 8.99</math> Hz, 2 H) 7.86 (d, <math>J = 9.38</math> Hz, 2 H) 8.08-8.17 (m, 1 H) 8.80 (d, <math>J = 2.35</math> Hz, 1 H) 8.90 (s, 2 H) 9.21 (s, 1 H) 10.20 (s, 1 H).</p>
252	<p>6-(1-amino-3-azabicyclo[3.1.0]hexan-3-yl)-N-(4-(chlorodifluoromethoxy)phenyl)-5-(pyrimidin-5-yl)nicotinamide</p>	<p>226/247.1 and tert-butyl 3-azabicyclo[3.1.0]hexan-1-ylcarbamate HPLC (Condition 4) <math>t_R = 4.34</math> min, UPLC-MS (Condition 3) <math>t_R = 0.78</math> min, <math>m/z = 473.1</math> <math>[M+H]^+</math>; <math>^1\text{H-NMR}</math> (400 MHz, <math>\text{DMSO-d}_6</math>) <math>\delta</math> ppm 0.31 (t, <math>J = 4.50</math> Hz, 1 H) 0.77 (dd, <math>J = 8.21, 4.69</math> Hz, 1 H) 1.27-1.40 (m, 1 H) 3.10 (d, <math>J = 10.17</math> Hz, 1 H) 3.32-3.51 (m, 5 H) 7.32 (d, <math>J = 8.99</math> Hz, 2 H) 7.83 (d, <math>J = 9.38</math> Hz, 2 H) 8.05 (d, <math>J = 2.35</math> Hz, 1 H) 8.75 (d, <math>J = 2.35</math> Hz, 1 H) 8.89 (d, <math>J = 0.78</math> Hz, 2 H) 9.20 (s, 1 H) 10.18 (s, 1 H).</p>

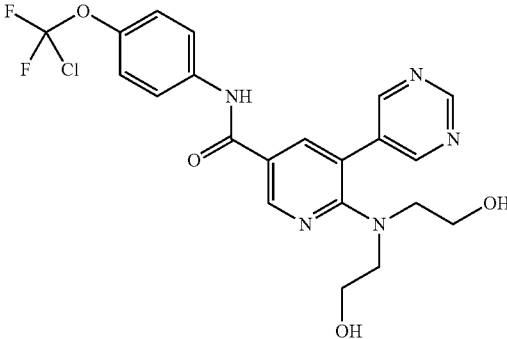
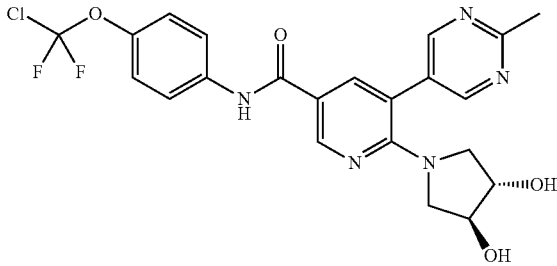
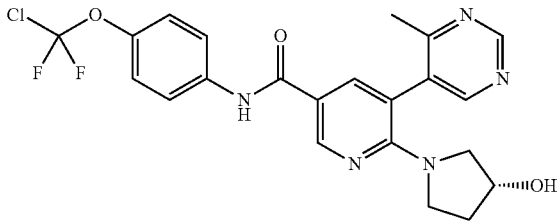
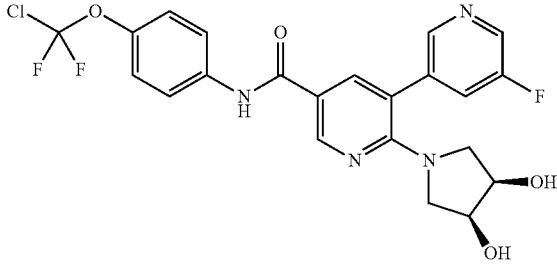
-continued

Ex.	Structure/Name	Example/Stage and starting material Analytics
253	 <p>6-((1R,5S,6S)-6-amino-3-azabicyclo[3.1.0]hexan-3-yl)-N-(4-(chlorodifluoromethoxy)phenyl)-5-(pyrimidin-5-yl)nicotinamide</p>	<p>226/247.1 and tert-butyl (1R,5S,6S)-3-azabicyclo[3.1.0]hexan-6-ylcarbamate HPLC (Condition 4) <math>t_R = 4.45</math> min, UPLC-MS (Condition 3) <math>t_R = 0.77</math> min, <math>m/z = 473</math> <math>[M + H]^+</math>; <math>^1H</math>-NMR (400 MHz, DMSO-<math>d_6</math>) <math>\delta</math> ppm 1.40 (br s, 2 H) 1.84 (s, 2 H) 3.16-3.25 (m, 2 H) 3.28-3.40 (m, 3 H) 7.32 (d, <math>J = 8.60</math> Hz, 2 H) 7.77-7.86 (m, 2 H) 8.02 (d, <math>J = 2.35</math> Hz, 1 H) 8.75 (d, <math>J = 2.35</math> Hz, 1 H) 8.86 (s, 2 H) 9.19 (s, 1 H) 10.17 (s, 1 H).</p>
254	 <p>N-(4-(chlorodifluoromethoxy)phenyl)-5-(pyrimidin-5-yl)-6-(pyrrolo[3,4-c]pyrazol-5(1H,4H,6H)-yl)nicotinamide</p>	<p>225/247.1 and 1,4,5,6-tetrahydropyrrolo[3,4-c]pyrazole HPLC (Condition 10) <math>t_R = 6.10</math> min, UPLC-MS (Condition 3) <math>t_R = 0.96</math> min, <math>m/z = 484</math> <math>[M + H]^+</math>; <math>^1H</math>-NMR (400 MHz, DMSO-<math>d_6</math>) <math>\delta</math> ppm 4.30 (s, 2H) 4.33 (s, 2H) 7.33 (d, <math>J = 8.60</math> Hz, 2 H) 7.48 (s, 1 H) 7.85 (d, <math>J = 8.60</math> Hz, 2 H) 8.07 (d, <math>J = 2.35</math> Hz, 1 H) 8.86 (d, <math>J = 2.35</math> Hz, 1 H) 8.97 (s, 2 H) 9.24 (s, 1 H) 10.22 (s, 1 H) 12.65 (br s, 1 H).</p>
255	 <p>(R)-6-(3-aminopiperidin-1-yl)-N-(4-(chlorodifluoromethoxy)phenyl)-5-(pyrimidin-5-yl)nicotinamide</p>	<p>226/247.1 and R-3-(Boc-amino)piperidine HPLC (Condition 10) <math>t_R = 5.86</math> min, UPLC-MS (Condition 3) <math>t_R = 0.79</math> min, <math>m/z = 475.1/477.1</math> <math>[M + H]^+</math>; <math>^1H</math>-NMR (400 MHz, DMSO-<math>d_6</math>) <math>\delta</math> ppm 1.03-1.16 (m, 1 H) 1.27-1.48 (m, 2 H) 1.49-1.59 (m, 1 H) 1.74-1.85 (m, 1 H) 2.40-2.51 (m, 2 H) 2.54-2.64 (m, 1 H) 2.64-2.74 (m, 1 H) 3.39-3.57 (m, 2 H) 7.36 (d, <math>J = 8.60</math> Hz, 2 H) 7.86 (d, <math>J = 9.38</math> Hz, 2 H) 8.18 (d, <math>J = 2.35</math> Hz, 1 H) 8.80 (d, <math>J = 2.35</math> Hz, 1 H) 9.07 (s, 2 H) 9.20 (s, 1 H) 10.31 (s, 1 H).</p>
256	 <p>N-(4-(chlorodifluoromethoxy)phenyl)-5-(pyrimidin-5-yl)-6-(4,7-diazaspiro[2.5]octan-7-yl)nicotinamide</p>	<p>226/247.1 and tert-butyl 4,7-diazaspiro[2.5]octane-4-carboxylate HPLC (Condition 4) <math>t_R = 4.37</math> min, UPLC-MS (Condition 3) <math>t_R = 0.80</math> min, <math>m/z = 487.1</math> <math>[M + H]^+</math>; <math>^1H</math>-NMR (400 MHz, DMSO-<math>d_6</math>) <math>\delta</math> ppm 0.20-0.28 (m, 2 H) 0.32-0.41 (m, 2 H) 2.25-2.42 (m, 1 H) 2.60-2.69 (m, 2 H) 2.99 (s, 2 H) 3.04-3.09 (m, 2 H) 7.34 (d, <math>J = 8.21</math> Hz, 2 H) 7.79-7.89 (m, 2 H) 8.17 (d, <math>J = 2.35</math> Hz, 1 H) 8.74-8.82 (m, 1 H) 9.01-9.09 (m, 2 H) 9.19 (d, <math>J = 0.78</math> Hz, 1 H) 10.31 (s, 1 H).</p>

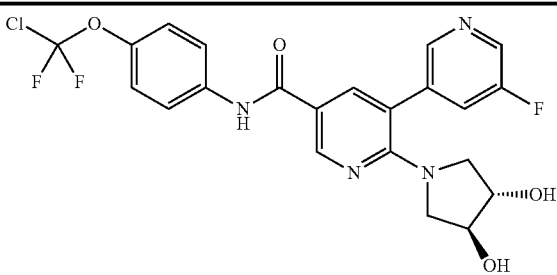
-continued

Ex.	Structure/Name	Example/Stage and starting material Analytics
257	 <p>N-(4-(chlorodifluoromethoxy)phenyl)-6-(trans-3-hydroxy-4-(hydroxymethyl)piperidin-1-yl)-5-(pyrimidin-5-yl)nicotinamide</p>	<p>250/247.1 and trans-4-(hydroxymethyl)piperidin-3-ol            UPLC-MS (Condition 3) <math>t_R = 0.90</math> min, <math>m/z = 505.9</math> <math>[M + H]^+</math>, <math>m/z = 503.9</math> <math>[M - H]^-</math>; <math>^1H</math>-NMR (400 MHz, DMSO-<math>d_6</math>) <math>\delta</math> ppm 1.14-1.27 (m, 1 H) 1.41-1.52 (m, 1 H) 1.52-1.61 (m, 1 H) 2.71-2.80 (m, 1 H) 2.91 (d, <math>J = 11.86</math> Hz, 1 H) 3.21-3.29 (m, 1 H) 3.42 (m, <math>J = 5.56, 3.85</math> Hz, 1 H) 3.54-3.69 (m, 2 H) 3.78 (br. s, 1 H) 4.35 (t, <math>J = 5.26</math> Hz, 1 H) 4.45 (d, <math>J = 3.91</math> Hz, 1 H) 7.36 (d, <math>J = 9.05</math> Hz, 2 H) 7.82-7.90 (m, 2 H) 8.17 (d, <math>J = 2.45</math> Hz, 1 H) 8.77 (d, <math>J = 2.45</math> Hz, 1 H) 9.10 (s, 2 H) 9.19 (s, 1 H) 10.30 (s, 1 H)</p>
258	 <p>N-(4-(chlorodifluoromethoxy)phenyl)-6-(3-hydroxyazetidin-1-yl)-5-(pyrimidin-5-yl)nicotinamide</p>	<p>224/247.1 and 3-hydroxyazetidine hydrochloride            HPLC (Condition 10) <math>t_R = 5.61</math> min, UPLC-MS (Condition 3) <math>t_R = 0.90</math>, <math>m/z = 448</math> <math>[M + H]^+</math>; <math>^1H</math>-NMR (400 MHz, DMSO-<math>d_6</math>) <math>\delta</math> ppm 3.50 (dd, <math>J = 9.38, 4.30</math> Hz, 2 H) 3.85-3.97 (m, 2 H) 4.35-4.44 (m, 1 H) 5.59 (d, <math>J = 6.26</math> Hz, 1 H) 7.35 (d, <math>J = 8.99</math> Hz, 2 H) 7.84 (d, <math>J = 8.99</math> Hz, 2 H) 8.10 (dd, <math>J = 2.35, 0.78</math> Hz, 1 H) 8.80 (dd, <math>J = 2.15, 0.98</math> Hz, 1 H) 8.92 (d, <math>J = 0.78</math> Hz, 2 H) 9.23 (d, <math>J = 0.78</math> Hz, 1 H) 10.23 (s, 1 H).</p>
259	 <p>6-(3-aminoazetidin-1-yl)-N-(4-(chlorodifluoromethoxy)phenyl)-5-(pyrimidin-5-yl)nicotinamide</p>	<p>226/247.1 and tert-butyl azetidin-3-ylcarbamate            HPLC (Condition 10) <math>t_R = 5.64</math> min, UPLC-MS (Condition 3) <math>t_R = 0.76</math> min, <math>m/z = 447.0/449.0</math> <math>[M + H]^+</math>; <math>^1H</math>-NMR (400 MHz, DMSO-<math>d_6</math>) <math>\delta</math> ppm 3.37 (dd, <math>J = 8.99, 5.47</math> Hz, 2 H) 3.57-3.67 (m, 1 H) 3.85 (t, <math>J = 8.02</math> Hz, 2 H) 7.35 (d, <math>J = 8.60</math> Hz, 2 H) 7.86 (m, <math>J = 9.00</math> Hz, 2 H) 8.08 (d, <math>J = 2.35</math> Hz, 1 H) 8.79 (d, <math>J = 2.35</math> Hz, 1 H) 8.91 (s, 2 H) 9.22 (s, 1 H) 10.20 (s, 1 H).</p>
260	 <p>N-(4-(chlorodifluoromethoxy)phenyl)-6-(3-(hydroxymethyl)azetidin-1-yl)-5-(pyrimidin-5-yl)nicotinamide</p>	<p>224/247.1 and 3-azetidinemethanol hydrochloride            HPLC (Condition 10) <math>t_R = 5.54</math> min, UPLC-MS (Condition 3) <math>t_R = 0.91</math> min, <math>m/z = 462.1</math> <math>[M + H]^+</math>; <math>^1H</math>-NMR (400 MHz, DMSO-<math>d_6</math>) <math>\delta</math> ppm 2.56-2.70 (m, 1 H) 3.40-3.55 (m, 4 H) 3.74 (t, <math>J = 8.41</math> Hz, 2 H) 4.71 (t, <math>J = 5.28</math> Hz, 1 H) 7.35 (d, <math>J = 8.99</math> Hz, 2 H) 7.81-7.90 (m, 2 H) 8.08 (d, <math>J = 2.35</math> Hz, 1 H) 8.79 (d, <math>J = 2.35</math> Hz, 1 H) 8.92 (s, 2 H) 9.22 (s, 1 H) 10.21 (s, 1 H).</p>

-continued

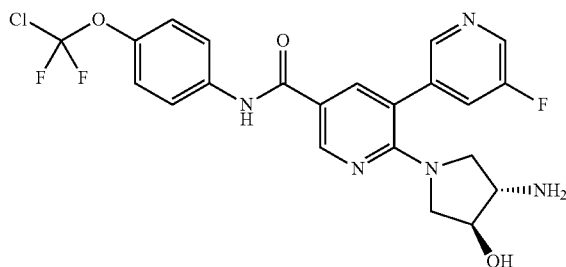
Ex.	Structure/Name	Example/Stage and starting material Analytics
261	 <p>6-(bis(2-hydroxyethyl)amino)-N-(4-(chlorodifluoromethoxy)phenyl)-5-(pyrimidin-5-yl)nicotinamide</p>	<p>224/247.1 and diethanolamine</p> <p>HPLC (Condition 10) <math>t_R = 5.52</math> min, UPLC-MS (Condition 3) <math>t_R = 0.76</math> min, <math>m/z = 480</math> <math>[M + H]^+</math>; <math>^1H</math>-NMR (400 MHz, DMSO-<math>d_6</math>) <math>\delta</math> ppm 2.64 (t, <math>J = 5.67</math> Hz, 2 H) 2.96 (t, <math>J = 5.67</math> Hz, 2 H) 3.44 (q, <math>J = 5.47</math> Hz, 2 H) 4.51 (t, <math>J = 5.47</math> Hz, 2 H) 7.39 (d, <math>J = 8.60</math> Hz, 2 H) 7.85-7.93 (d, <math>J = 8.60</math> Hz, 2 H) 7.87 8.50 (d, <math>J = 2.35</math> Hz, 1 H) 8.84 (d, <math>J = 2.35</math> Hz, 1 H) 9.18 (s, 2 H) 9.22 (s, 1 H) 10.47 (s, 1 H).</p>
262	 <p>N-(4-(chlorodifluoromethoxy)phenyl)-6-((3S,4S)-3,4-dihydroxypyrrolidin-1-yl)-5-(2-methylpyrimidin-5-yl)nicotinamide</p>	<p>244/248.1 and 2-methylpyrimidin-5-ylboronic acid</p> <p>UPLC-MS (Condition 3) <math>t_R = 0.87</math> min, <math>m/z = 492.1</math> <math>[M + H]^+</math>, <math>m/z = 536.1</math> <math>[M + \text{formic acid} - H]^+</math>; <math>^1H</math>-NMR (400 MHz, DMSO-<math>d_6</math>) <math>\delta</math> ppm 2.69 (s, 3 H) 2.96 (d, <math>J = 11.49</math> Hz, 2 H) 3.42 (dd, <math>J = 11.49</math>, 3.42 Hz, 2 H) 3.88 (br. s, 2 H) 5.08 (d, <math>J = 3.18</math> Hz, 2 H) 7.35 (d, <math>J = 9.05</math> Hz, 2 H) 7.82-7.90 (m, 2 H) 8.06 (d, <math>J = 2.32</math> Hz, 1 H) 8.75 (s, 2 H) 8.77 (d, <math>J = 2.32</math> Hz, 1 H) 10.18 (s, 1 H).</p>
263	 <p>(R)-N-(4-(chlorodifluoromethoxy)phenyl)-6-(3-hydroxypyrrolidin-1-yl)-5-(4-methylpyrimidin-5-yl)nicotinamide</p>	<p>282/171.1 and 297.1</p> <p>UPLC-MS (Condition 3), <math>t_R = 0.94</math> min, <math>m/z = 476.1/478.1</math> <math>[M + H]^+</math>; <math>^1H</math>-NMR (600 MHz, DMSO-<math>d_6</math>) <math>\delta</math> ppm 1.66-1.92 (m, 2 H) 2.18-2.38 (m, 3 H) 2.75-3.35 (m, 4 H) 4.13-4.24 (m, 1 H) 4.83-4.96 (m, 1 H) 7.34 (d, <math>J = 8.47</math> Hz, 2 H) 7.85 (d, <math>J = 8.85</math> Hz, 2 H) 7.97-8.04 (m, 1 H) 8.64-8.85 (m, 2 H) 9.08 (s, 1 H) 10.11-10.20 (m, 1 H).</p>
264	 <p>N-(4-(chlorodifluoromethoxy)phenyl)-2-(cis-3,4-dihydroxypyrrolidin-1-yl)-5'-fluoro-[3,3'-bipyridine]-5-carboxamide</p>	<p>244/249.1 and 5-fluoropyridin-3-ylboronic acid (purification by preparative SFC) UPLC-MS (Condition 3) <math>t_R = 0.96</math> min, <math>m/z = 495.1</math> <math>[M + H]^+</math>, <math>m/z = 539.1</math> <math>[M + \text{formic acid} - H]^+</math>; <math>^1H</math>-NMR (400 MHz, DMSO-<math>d_6</math>) <math>\delta</math> ppm 3.05 (dd, <math>J = 10.88</math>, 4.28 Hz, 2 H) 3.25 (dd, <math>J = 10.76</math>, 5.38 Hz, 2 H) 3.97 (br. s, 2 H) 4.87 (s, 2 H) 7.34 (d, <math>J = 9.29</math> Hz, 2 H) 7.79-7.84 (m, 1 H) 7.84-7.89 (m, 2 H) 8.08 (d, <math>J = 2.20</math> Hz, 1 H) 8.50 (t, 1 H) 8.61 (d, <math>J = 2.69</math> Hz, 1 H) 8.78 (d, <math>J = 2.20</math> Hz, 1 H) 10.18 (s, 1 H).</p>

-continued

Ex.	Structure/Name	Example/Stage and starting material Analytics
265	 <p>N-(4-(chlorodifluoromethoxy)phenyl)-2-((3S,4S)-3,4-dihydroxypyrrolidin-1-yl)-5'-fluoro-[3,3'-bipyridine]-5-carboxamide</p>	<p>244/248.1 and 5-fluoropyridin-3-ylboronic acid            UPLC-MS (Condition 3) <math>t_R</math> = 0.96 min, <math>m/z</math> = 495.0 <math>[M + H]^+</math>, <math>m/z</math> = 492.9 <math>[M - H]^-</math>; <math>^1H</math>-NMR (400 MHz, DMSO-<math>d_6</math>) <math>\delta</math> ppm 2.95 (d, J = 11.62 Hz, 2 H) 3.42 (dd, J = 11.43, 3.24 Hz, 2 H) 3.87 (br. s, 2 H) 5.08 (d, J = 2.45 Hz, 2 H) 7.34 (d, J = 9.05 Hz, 2 H) 7.79-7.92 (m, 3 H) 8.09 (d, J = 2.32 Hz, 1 H) 8.50 (s, 1 H) 8.61 (d, J = 2.69 Hz, 1 H) 8.78 (d, J = 2.32 Hz, 1 H) 10.19 (s, 1 H).</p>

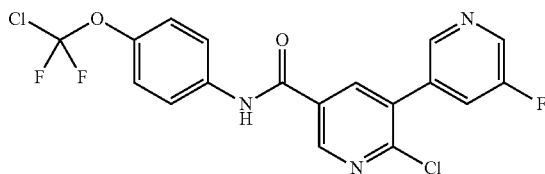
## Example 266

2-((3S,4S)-3-Amino-4-hydroxypyrrolidin-1-yl)-N-(4-(chlorodifluoromethoxy)phenyl)-5'-fluoro-[3,3'-bipyridine]-5-carboxamide



2-Chloro-N-(4-(chlorodifluoromethoxy)phenyl)-5'-fluoro-[3,3'-bipyridine]-5-carboxamide (Stage 266.1, 70 mg, 0.160 mmol) and DIPEA (0.196 mL, 1.121 mmol) were added to a vial containing iPrOH (2 mL). (3S,4S)-4-Aminopyrrolidin-3-ol (30 mg, 0.168 mmol) was added. The mixture was stirred at 80° C. for 44 h. The RM was treated with sat. aq.  $Na_2CO_3$  (20 mL) and extracted with EtOAc. The combined extracts were washed with brine (10 mL), dried over  $Na_2SO_4$ , filtered and evaporated to dryness under reduced to give the crude product which was purified by flash chromatography (Silica gel column, 4 g, DCM/MeOH, from 95:5 to 8:2) to afford the title product as a beige solid. HPLC (Condition 10)  $t_R$  = 5.83 min, UPLC-MS (Condition 3)  $t_R$  = 0.81 min,  $m/z$  = 494.2/496.2  $[M+H]^+$ ;  $^1H$ -NMR (400 MHz, DMSO- $d_6$ )  $\delta$  ppm 2.91 (dd, J = 11.53, 2.93 Hz, 1H) 3.22-3.28 (m, 1H) 3.36-3.46 (m, 2H) 3.59-3.66 (m, 1H) 4.02-4.08 (m, 1H) 5.48 (d, J = 3.91 Hz, 1H) 7.35 (d, J = 8.60 Hz, 2H) 7.87 (m, J = 9.00 Hz, 3H) 8.13 (d, J = 2.35 Hz, 1H) 8.55 (s, 1H) 8.64 (d, J = 2.74 Hz, 1H) 8.79-8.83 (m, 1H) 10.22 (s, 1H).

Stage 266.1 2-Chloro-N-(4-(chlorodifluoromethoxy)phenyl)-5'-fluoro-[3,3'-bipyridine]-5-carboxamide



20

The title compound was prepared in an analogous fashion to that described in Stage 247.1 using 6-chloro-N-(4-(chlorodifluoromethoxy)phenyl)-5-iodonicotinamide (Stage 247.2) and 3-Fluoropyridine-5-boronic acid pinacol ester (80° C. instead of 90° C.) to afford a white solid. UPLC-MS (Condition 3)  $t_R$  = 1.17 min,  $m/z$  = 428.0/429.9  $[M+H]^+$ .

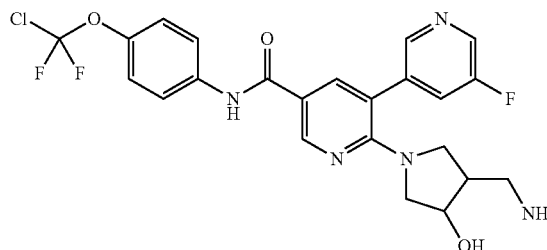
25

## Example 267

2-(3-(Aminomethyl)-4-hydroxypyrrolidin-1-yl)-N-(4-(chlorodifluoromethoxy)phenyl)-5'-fluoro-[3,3'-bipyridine]-5-carboxamide

30

35



40

45

50

55

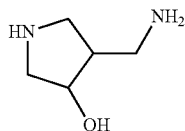
60

65

2-Chloro-N-(4-(chlorodifluoromethoxy)phenyl)-5'-fluoro-[3,3'-bipyridine]-5-carboxamide (Stage 266.1, 80 mg, 0.183 mmol) and DIPEA (0.224 mL, 1.282 mmol) were added to a vial containing iPrOH (2 mL) and 4-(aminomethyl)pyrrolidin-3-ol dihydrochloride (Stage 267.1, 37.1 mg, 0.192 mmol) was added under an argon atmosphere. The RM was stirred at 80° C. for 3 days. The RM was treated with sat. aq.  $Na_2CO_3$  (20 mL) and extracted with EtOAc. The combined extracts were washed with brine (10 mL), dried over  $Na_2SO_4$ , filtered and evaporated to dryness under reduced pressure to give the crude product was purified by preparative HPLC (Condition 14). Fractions containing product were treated with sat. aq.  $Na_2CO_3$  and the MeCN was evaporated off under reduced pressure. The resulting aq. residue was extracted with EtOAc and the combined extracts were dried over  $Na_2SO_4$ , filtered and evaporated. The residue was suspended in DCM/ $Et_2O$ /n-hexane. The obtained solid was filtered off, washed with  $Et_2O$ , n-hexane and dried to afford the title product as a white solid. HPLC (Condition 10)  $t_R$  = 5.74 min, UPLC-MS (Condition 3)  $t_R$  = 0.83 min,  $m/z$  = 508  $[M+H]^+$ ;  $^1H$ -NMR (400 MHz, DMSO- $d_6$ )  $\delta$  ppm 2.41-3.33 (m, 7H) 3.92-4.21 (m, 1H) 7.34 (d, J = 8.99 Hz, 2H) 7.85 (d, J = 9.38 Hz, 3H) 8.03-8.11 (m, 1H) 8.47-8.54 (m, 1H) 8.59 (m, J = 2.70 Hz, 1H) 8.77 (m, J = 2.30 Hz, 1H) 10.19 (s, 1H).

## 275

Stage 267.1 4-(Aminomethyl)pyrrolidin-3-ol  
dihydrochloride



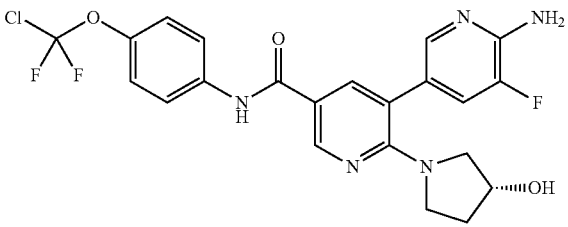
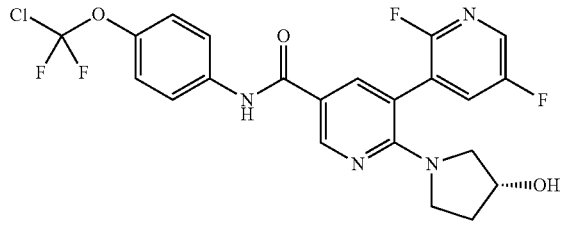
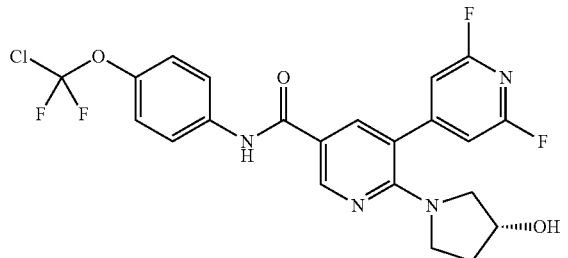
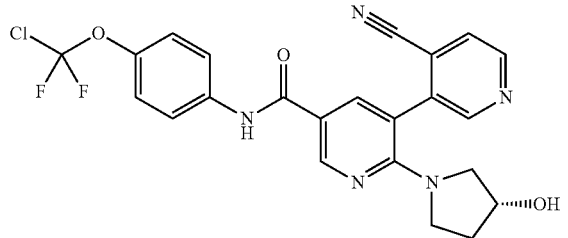
10

## 276

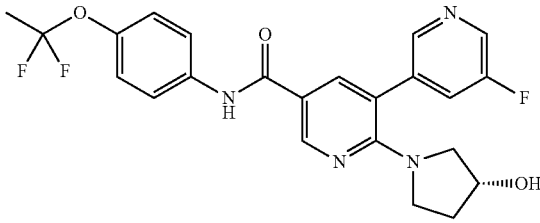
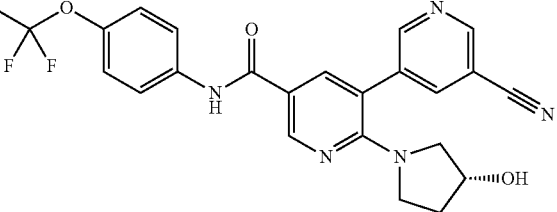
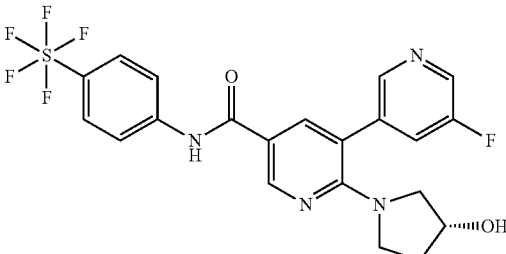
A mixture of 1-N-Boc-cis-(3-(aminomethyl)-4-hydroxy)pyrrolidine (0.3 g, 1.359 mmol) and HCl in EtOH (10.87 mL, 13.59 mmol) were stirred at RT for 24 h. the solvent was evaporated off under reduced pressure and the residue was suspended in n-hexane, filtered, washed with n-hexane and dried to afford the crude title product as a grey solid.

## Example 268-277

Ex.	Structure/Name	Example/Stage and starting material Analytics
268	<p>N-(4-(chlorodifluoromethoxy)phenyl)-5'-cyano-2-(cis-3,4-dihydroxypyrrolidin-1-yl)-[3,3'-bipyridine]-5-carboxamide</p>	<p>244/249.1 and 3-cyanopyridine-5-boronic acid UPLC-MS (Condition 3) <math>t_R = 0.95</math> min, <math>m/z = 502.1</math> <math>[M + H]^+</math>, <math>m/z = 546.1</math> <math>[M + \text{formic acid} - H]</math>; <math>^1\text{H-NMR}</math> (400 MHz, <math>\text{DMSO-d}_6</math>) <math>\delta</math> ppm 3.03 (dd, <math>J = 10.88, 4.16</math> Hz, 2 H) 3.19-3.28 (m, 2 H) 3.91-4.02 (m, 2 H) 4.90 (d, <math>J = 4.89</math> Hz, 2 H) 7.35 (d, <math>J = 9.17</math> Hz, 2 H) 7.82-7.92 (m, 2 H) 8.10 (d, <math>J = 2.32</math> Hz, 1 H) 8.39 (t, <math>J = 2.08</math> Hz, 1 H) 8.79 (d, <math>J = 2.32</math> Hz, 1 H) 8.89 (d, <math>J = 2.20</math> Hz, 1 H) 9.04 (d, <math>J = 1.96</math> Hz, 1 H) 10.19 (s, 1 H).</p>
269	<p>N-(4-(chlorodifluoromethoxy)phenyl)-5'-cyano-2-((3S,4S)-3,4-dihydroxypyrrolidin-1-yl)-[3,3'-bipyridine]-5-carboxamide</p>	<p>244/248.1 and 3-cyanopyridine-5-boronic acid pinacol ester to afford an off-white solid. UPLC-MS (Condition 3) <math>t_R = 0.93</math> min, <math>m/z = 502.1</math> <math>[M + H]^+</math>, <math>m/z = 546.1</math> <math>[M + \text{formic acid} - H]</math>; <math>^1\text{H-NMR}</math> (400 MHz, <math>\text{DMSO-d}_6</math>) <math>\delta</math> ppm 2.93 (d, <math>J = 11.37</math> Hz, 2 H) 3.41 (dd, <math>J = 11.49, 3.18</math> Hz, 2 H) 3.84-3.91 (m, 2 H) 5.08 (d, <math>J = 3.30</math> Hz, 2 H) 7.35 (d, <math>J = 9.17</math> Hz, 2 H) 7.82-7.90 (m, 2 H) 8.10 (d, <math>J = 2.45</math> Hz, 1 H) 8.42 (s, 1 H) 8.79 (d, <math>J = 2.32</math> Hz, 1 H) 8.89 (d, <math>J = 1.83</math> Hz, 1 H) 9.04 (d, <math>J = 1.96</math> Hz, 1 H) 10.19 (s, 1 H).</p>
270	<p>(R)-N-(4-(chlorodifluoromethoxy)phenyl)-2-(3-hydroxypyrrolidin-1-yl)-2'-methyl-[3,3'-bipyridine]-5-carboxamide</p>	<p>169/171.1 and 2-methyl-3-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)pyridine HPLC (Condition 4) <math>t_R = 4.29</math> min, UPLC-MS (Condition 3) <math>t_R = 0.91</math> min, <math>m/z = 475</math> <math>[M + H]^+</math>; <math>^1\text{H-NMR}</math> (400 MHz, <math>\text{DMSO-d}_6</math>) <math>\delta</math> ppm 1.60-1.90 (m, 2 H) 2.13-2.35 (m, 3 H) 2.93 (d, <math>J = 11.34</math> Hz, 1 H) 3.02-3.22 (m, 3 H) 4.17 (br s, 1 H) 4.76-4.91 (m, 1 H) 7.24-7.37 (m, 3 H) 7.59-7.80 (m, 1 H) 7.81-7.87 (m, 2 H) 7.91 (d, <math>J = 1.96</math> Hz, 1 H) 8.47 (d, <math>J = 4.69</math> Hz, 1 H) 8.76 (dd, <math>J = 2.35, 0.78</math> Hz, 1 H) 10.07-10.14 (m, 1 H).</p>

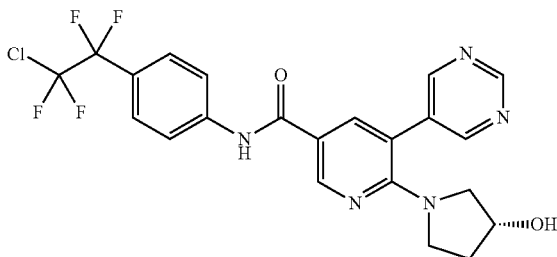
Ex.	Structure/Name	Example/Stage and starting material Analytics
271	 <p>(R)-6'-amino-N-(4-(chlorodifluoromethoxy)phenyl)-5'-fluoro-2-(3-hydroxypyrrolidin-1-yl)-[3,3'-bipyridine]-5-carboxamide</p>	<p>169/171.1 and 3-fluoro-5-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)pyridin-2-amine to afford a white amorphous powder. HPLC (Condition 4) <math>t_R = 4.57</math> min, UPLC-MS (Condition 3) <math>t_R = 0.95</math> min, <math>m/z = 494</math> <math>[M + H]^+</math>; <math>^1H</math>-NMR (400 MHz, DMSO-<math>d_6</math>) <math>\delta</math> ppm 1.64-1.89 (m, 2 H) 2.94 (d, <math>J = 11.34</math> Hz, 1 H) 3.19-3.54 (m, 4 H) 4.19 (br. s, 1 H) 6.36 (br. s, 2 H) 7.31 (d, <math>J = 8.99</math> Hz, 2 H) 7.41 (dd, <math>J = 11.93, 1.76</math> Hz, 1 H) 7.77 (s, 1 H) 7.80-7.89 (m, 2 H) 7.94 (d, <math>J = 2.35</math> Hz, 1 H) 8.68 (d, <math>J = 2.35</math> Hz, 1 H) 10.12 (s, 1 H).</p>
272	 <p>(R)-N-(4-(chlorodifluoromethoxy)phenyl)-2',5'-difluoro-2-(3-hydroxypyrrolidin-1-yl)-[3,3'-bipyridine]-5-carboxamide</p>	<p>169/171.1 and 2,5-difluoro-3-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)pyridin-2-amine to afford a white amorphous powder. HPLC (Condition 4) <math>t_R = 5.9</math> min, UPLC-MS (Condition 3) <math>t_R = 1.08</math> min, <math>m/z = 497.2</math> <math>[M + H]^+</math>; <math>^1H</math>-NMR (400 MHz, DMSO-<math>d_6</math>) <math>\delta</math> ppm 1.67-1.91 (m, 2 H) 2.88-2.99 (m, 1 H) 3.23 (br. s, 2 H) 3.35-3.48 (m, 1 H) 4.15-4.26 (m, 1 H) 4.81-4.92 (m, 1 H) 7.31 (d, <math>J = 1.00</math> Hz, 2 H) 7.39-7.55 (m, 1 H) 7.84 (d, <math>J = 8.99</math> Hz, 2 H) 8.09 (d, <math>J = 1.96</math> Hz, 1 H) 8.33 (s, 1 H) 8.73-8.84 (m, 1 H) 10.18 (s, 1 H).</p>
273	 <p>(R)-N-(4-(chlorodifluoromethoxy)phenyl)-2',6'-difluoro-2-(3-hydroxypyrrolidin-1-yl)-[3,4'-bipyridine]-5-carboxamide</p>	<p>169/171.1 and 2,6-difluoropyridin-4-ylboronic acid to afford a white amorphous powder. HPLC (Condition 4) <math>t_R = 5.83</math> min, UPLC-MS (Condition 3) <math>t_R = 1.13</math> min, <math>m/z = 497.1</math> <math>[M + H]^+</math>; <math>^1H</math>-NMR (400 MHz, DMSO-<math>d_6</math>) <math>\delta</math> ppm 1.71-1.81 (m, 1 H) 1.87 (m, <math>J = 8.60, 4.30</math> Hz, 1 H) 2.86 (d, <math>J = 11.34</math> Hz, 1 H) 3.21-3.29 (m, 2 H) 3.47 (m, <math>J = 7.40</math> Hz, 1 H) 4.22 (br. s, 1 H) 4.87 (d, <math>J = 2.74</math> Hz, 1 H) 7.24 (s, 2 H) 7.33 (d, <math>J = 8.60</math> Hz, 2 H) 7.79-7.90 (m, 2 H) 8.13 (d, <math>J = 2.35</math> Hz, 1 H) 8.78 (d, <math>J = 2.35</math> Hz, 1 H) 10.18 (s, 1 H).</p>
274	 <p>(R)-N-(4-(chlorodifluoromethoxy)phenyl)-4'-cyano-2-(3-hydroxypyrrolidin-1-yl)-[3,3'-bipyridine]-5-carboxamide</p>	<p>240/171.1 and 4-cyanopyridine-3-boronic acid pinacol ester to afford a white amorphous powder. HPLC (Condition 10) <math>t_R = 6.06</math> min, UPLC-MS (Condition 3) <math>t_R = 0.99</math> min, <math>m/z = 486</math> <math>[M + H]^+</math>; <math>^1H</math>-NMR (400 MHz, DMSO-<math>d_6</math>) <math>\delta</math> ppm 1.65-1.98 (m, 2 H) 2.85 (d, <math>J = 10.95</math> Hz, 1 H) 3.08-3.19 (m, 1 H) 3.19-3.45 (m, 2 H) 4.14-4.26 (m, 1 H) 4.82-4.98 (m, 1 H) 7.35 (d, <math>J = 8.60</math> Hz, 2 H) 7.86 (d, <math>J = 8.99</math> Hz, 2 H) 7.94-8.05 (m, 1 H) 8.12 (d, <math>J = 7.04</math> Hz, 1 H) 8.79-9.08 (m, 3 H) 10.22 (s, 1 H).</p>

-continued

Ex.	Structure/Name	Example/Stage and starting material Analytics
275	 <p>(R)-N-(4-(1,1-difluoroethoxy)phenyl)-5'-fluoro-2-(3-hydroxypyrrolidin-1-yl)-[3,3'-bipyridine]-5-carboxamide</p>	245/215.1 and 3-fluoropyridine-5-boronic acid pinacol ester HPLC (Condition 10) $t_R$ = 5.83 min, UPLC-MS (Condition 3) $t_R$ = 0.94 min, $m/z$ = 459.1 $[M + H]^+$ ; $^1H$ -NMR (400 MHz, DMSO- $d_6$ ) $\delta$ ppm 1.69-1.79 (m, 1 H) 1.80-1.88 (m, 1 H) 1.88-1.99 (m, 3 H) 2.87 (d, $J$ = 11.34 Hz, 1 H) 3.17-3.28 (m, 2 H) 3.35-3.45 (m, 1 H) 4.21 (br. s, 1 H) 4.86 (dd, $J$ = 3.52, 1.17 Hz, 1 H) 7.17 (d, $J$ = 8.60 Hz, 2 H) 7.75 (d, $J$ = 8.99 Hz, 2 H) 7.80-7.86 (m, 1 H) 8.07 (dd, $J$ = 2.35, 1.17 Hz, 1 H) 8.50-8.53 (m, 1 H) 8.58-8.61 (m, 1 H) 8.77 (dd, $J$ = 2.35, 1.17 Hz, 1 H) 10.07 (s, 1 H).
276	 <p>R)-5'-cyano-N-(4-(1,1-difluoroethoxy)phenyl)-2-(3-hydroxypyrrolidin-1-yl)-[3,3'-bipyridine]-5-carboxamide</p>	245/215.1 and 3-cyanopyridine-5-boronic acid pinacol ester HPLC (Condition 10) $t_R$ = 5.85 min, UPLC-MS (Condition 3) $t_R$ = 0.94 min, $m/z$ = 466.3 $[M + H]^+$ ; $^1H$ -NMR (400 MHz, DMSO- $d_6$ ) $\delta$ ppm 1.70-1.79 (m, 1 H) 1.81-1.90 (m, 1 H) 1.93 (t, $J$ = 13.88 Hz, 3 H) 2.87 (d, $J$ = 11.34 Hz, 1 H) 3.17-3.26 (m, 2 H) 3.34-3.43 (m, 1 H) 4.21 (br. s, 1 H) 4.88 (d, $J$ = 3.52 Hz, 1 H) 7.18 (d, $J$ = 8.99 Hz, 2 H) 7.76 (m, $J$ = 9.00 Hz, 2 H) 8.09 (d, $J$ = 2.35 Hz, 1 H) 8.37-8.43 (m, 1 H) 8.79 (d, $J$ = 2.35 Hz, 1 H) 8.90 (d, $J$ = 2.35 Hz, 1 H) 9.02 (d, $J$ = 1.96 Hz, 1 H) 10.08 (s, 1 H).
277	 <p>(R)-5'-fluoro-2-(3-hydroxypyrrolidin-1-yl)-N-(4-(pentafluorosulfanyl)phenyl)-[3,3'-bipyridine]-5-carboxamide</p>	169/216.1 and 3-fluoro-5-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)pyridine HPLC (Condition 4) $t_R$ = 5.42 min, UPLC-MS (Condition 3) $t_R$ = 1.05 min, $m/z$ = 505.1 $[M + H]^+$ ; $^1H$ -NMR (400 MHz, DMSO- $d_6$ ) $\delta$ ppm 1.69-1.78 (m, 1 H) 1.80-1.91 (m, 1 H) 2.81-2.91 (m, 1 H) 3.16-3.27 (m, 2 H) 3.34-3.45 (m, 1 H) 4.15-4.24 (m, 1 H) 4.86 (d, $J$ = 3.13 Hz, 1 H) 7.77-7.91 (m, 3 H) 7.92-8.00 (m, 2 H) 8.05-8.11 (m, 1 H) 8.50 (d, $J$ = 1.17 Hz, 1 H) 8.56-8.61 (m, 1 H) 8.74-8.82 (m, 1 H) 10.36 (s, 1 H).

## Example 278

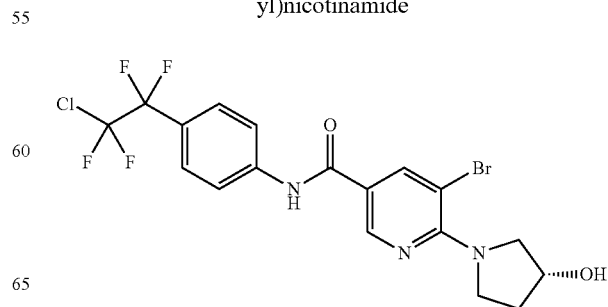
(R)-N-(4-(2-Chloro-1,1,2,2-tetrafluoroethyl)phenyl)-6-(3-hydroxypyrrolidin-1-yl)-5-(pyrimidin-5-yl)nicotinamide



The title compound was prepared in an analogous fashion to that described in Example 169 using (R)-5-bromo-N-(4-(2-chloro-1,1,2,2-tetrafluoroethyl)phenyl)-6-(3-hydroxypyrrolidin-1-yl)nicotinamide (Stage 278.1) and pyrimidin-5-ylboronic acid to afford an amorphous white powder. HPLC (Condition 4)  $t_R$  = 5.21 min, UPLC-MS (Condition 3)  $t_R$  = 0.99

45 min,  $m/z$  = 496.1  $[M + H]^+$ ;  $^1H$ -NMR (400 MHz, DMSO- $d_6$ )  $\delta$  ppm 1.66-1.77 (m, 1H) 1.78-1.89 (m, 1H) 2.82-2.92 (m, 1H) 3.14-3.26 (m, 2H) 3.32-3.42 (m, 1H) 4.15-4.26 (m, 1H) 4.87 (d,  $J$  = 3.13 Hz, 1H) 7.63 (d,  $J$  = 8.99 Hz, 2H) 7.97 (d,  $J$  = 8.60 Hz, 2H) 8.10 (dd,  $J$  = 2.35, 0.78 Hz, 1H) 8.79 (dd,  $J$  = 2.35, 0.78 Hz, 1H) 8.88 (d,  $J$  = 0.78 Hz, 2H) 9.18 (d,  $J$  = 0.78 Hz, 1H) 10.31 (s, 1H).

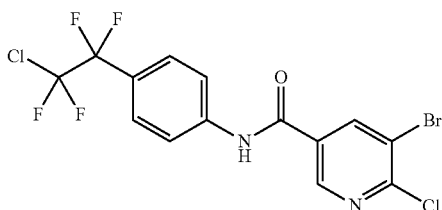
Stage 278.1 (R)-5-Bromo-N-(4-(2-chloro-1,1,2,2-tetrafluoroethyl)phenyl)-6-(3-hydroxypyrrolidin-1-yl)nicotinamide



## 281

The title compound was prepared in an analogous fashion to that described in Stage 171.1 using 5-bromo-6-chloro-N-(4-(2-chloro-1,1,2,2-tetrafluoroethyl)phenyl)nicotinamide (Stage 278.2) and (R)-pyrrolidin-3-ol to afford a white powder. HPLC (Condition 4)  $t_R$ =6.05 min, UPLC-MS (Condition 3)  $t_R$ =1.18 min,  $m/z$ =498  $[M+H]^+$ .

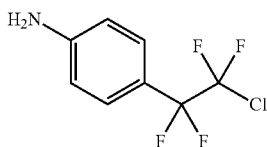
Stage 278.2 5-Bromo-6-chloro-N-(4-(2-chloro-1,1,2,2-tetrafluoroethyl)phenyl)nicotinamide



The title compound was prepared in an analogous fashion to that described in Stage 169.2 using 4-(2-chloro-1,1,2,2-tetrafluoroethyl)aniline (Stage 278.3) and 5-bromo-6-chloronicotinic acid to afford a beige crystalline powder. HPLC (Condition 4)  $t_R$ =6.77 min, UPLC-MS (Condition 3)  $t_R$ =1.31 min,  $m/z$ =444.8  $[M-H]^-$ .

Stage 278.3

4-(2-Chloro-1,1,2,2-tetrafluoroethyl)aniline



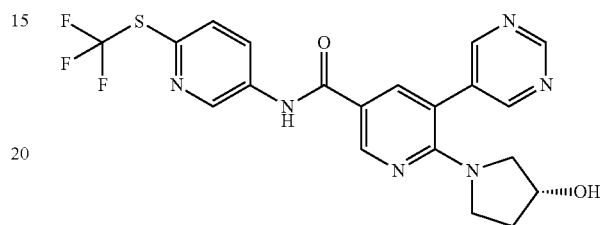
$Ni(PPh_3)_4$  (222 mg, 0.2 mmol) was added to a mixture of aniline (745 mg, 8 mmol) and 1-chloro-1,1,2,2-tetrafluoro-2-iodoethane (1049 mg, 4 mmol) in DMF (10 mL) in a MW vial under an argon atmosphere. The vial was sealed and the RM was stirred for two days at 80° C. After cooling at RT, the RM was dissolved in  $Et_2O$ , washed with  $NaHCO_3$  10% and brine, dried over  $MgSO_4$  and the solvent was evaporated off under reduced pressure to give a residue which was purified by flash chromatography (RediSep® Silica gel column, n-heptane/ $EtOAc$ , from 0 to 25%  $EtOAc$ ) and further by reverse phase chromatography (MPLC, Lichroprep® 15-25  $\mu m$  column, eluents: water+0.1% formic/ $MeCN$ +0.1% formic acid, gradient 10 to 50%  $MeCN$ +0.1% formic acid). The fractions containing pure product were combined and the  $MeCN$  was evaporated off under reduced pressure to give an aq. phase which was neutralized with  $NaHCO_3$  and extracted with  $Et_2O$ . The combined extracts were dried over  $MgSO_4$  and the solvent was evaporated off under reduced pressure to afford

## 282

the title compound as a red oil. HPLC (Condition 4)  $t_R$ =5.48 min, UPLC-MS (Condition 3)  $t_R$ =1.04 min,  $m/z$ =269  $[M+H]^+$ .

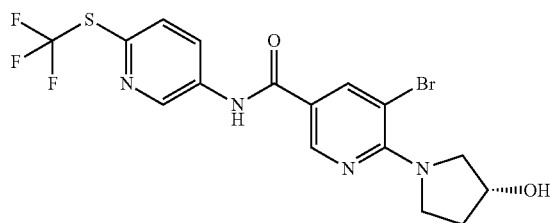
Example 279

(R)-6-(3-Hydroxypyrrolidin-1-yl)-5-(pyrimidin-5-yl)-N-(6-((trifluoromethyl)thio)pyridin-3-yl)nicotinamide



The title compound was prepared in an analogous fashion to that described in Example 169 using (R)-5-bromo-6-(3-hydroxypyrrolidin-1-yl)-N-(6-((trifluoromethyl)thio)pyridin-3-yl)nicotinamide (Stage 279.1) and pyrimidin-5-ylboronic acid to afford a white resinous powder. HPLC (Condition 4)  $t_R$ =4.41 min, UPLC-MS (Condition 3)  $t_R$ =0.83 min,  $m/z$ =463.2  $[M+H]^+$ ;  $^1H$ -NMR (400 MHz,  $DMSO-d_6$ )  $\delta$  ppm 1.68-1.93 (m, 2H) 2.91 (d,  $J$ =11.34 Hz, 1H) 3.20-3.44 (m, 3H) 4.22 (br. s, 1H) 4.90 (d,  $J$ =3.52 Hz, 1H) 7.81 (d,  $J$ =8.60 Hz, 1H) 8.07-8.16 (m, 1H) 8.29-8.38 (m, 1H) 8.80-8.85 (m, 1H) 8.90 (s, 2H) 8.95-9.03 (m, 1H) 9.17-9.24 (m, 1H) 10.44 (s, 1H).

Stage 279.1 (R)-5-Bromo-6-(3-hydroxypyrrolidin-1-yl)-N-(6-((trifluoromethyl)thio)pyridin-3-yl)nicotinamide

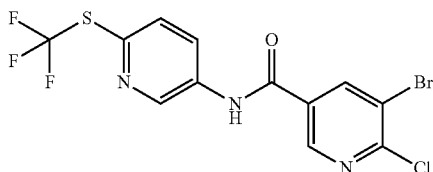


The title compound was prepared in an analogous fashion to that described in Stage 171.1 using 5-bromo-6-chloro-N-(6-((trifluoromethyl)thio)pyridin-3-yl)nicotinamide (Stage 279.2) and (R)-pyrrolidin-3-ol to afford an off-white powder.

## 283

HPLC (Condition 4)  $t_R$ =5.53 min, UPLC-MS (Condition 3)  $t_R$ =1.01 min,  $m/z$ =463.1  $[M+H]^+$ .

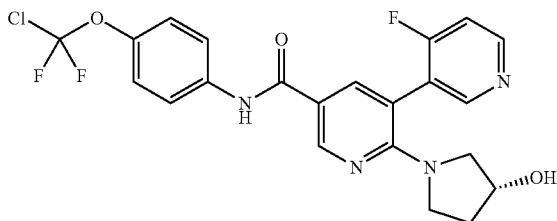
Stage 279.2 5-Bromo-6-chloro-N-(6-((trifluoromethylthio)pyridin-3-yl)nicotinamide



The title compound was prepared in an analogous fashion to that described in Stage 169.2 using 5-bromo-6-chloronicotinic acid and 6-(trifluoromethylthio)pyridin-3-amine to afford an off-white powder. HPLC (Condition 4)  $t_R$ =6.43 min, UPLC-MS (Condition 3)  $t_R$ =1.15 min,  $m/z$ =411.9  $[M-H]^-$ .

## Example 280

(R)—N-(4-(Chlorodifluoromethoxy)phenyl)-4'-fluoro-2-(3-hydroxypyrrolidin-1-yl)-[3,3'-bipyridine]-5-carboxamide



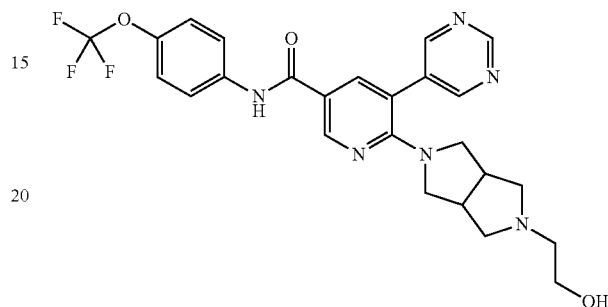
(R)-5-Bromo-N-(4-(chlorodifluoromethoxy)phenyl)-6-(3-hydroxypyrrolidin-1-yl)nicotinamide (Stage 171.1, 116 mg, 0.25 mmol) and 4-fluoro-3-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)pyridine (116 mg, 0.5 mmol) were dissolved in DME (1 mL). A solution of 2 M  $Na_2CO_3$  (0.375 mL, 0.75 mmol) was added, the mixture was flushed with argon and  $PdCl_2(dppf)$  (9 mg, 0.013 mmol) was added and the RM was stirred at 120° C. for 1 h. Additional 4-fluoro-3-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)pyridine (80 mg) and  $PdCl_2(dppf)$  (9 mg, 0.013 mmol) were then added and the RM was stirred at 120° C. for further 45 min. After cooling at RT, the RM was treated with EtOAc, washed with brine dried over  $Na_2SO_4$ . The solvent was evaporated under reduced pressure to give a residue that was purified by flash chromatography (RediSep® Silica gel column, 12 g, EtOAc/2% MeOH in EtOAc, gradient 50 to 100% B, EtOAc/MeOH 10%) and treated with Si-Thiol (100 mg) in MeOH. The product was further purified by preparative SFC (Column Diol, from 21% to 26% in 6 min) to afford the title product as a beige foam. HPLC (Condition 4)  $t_R$ =5.14 min, UPLC-MS (Condition 3)  $t_R$ =0.98 min,  $m/z$ =479.2  $[M+H]^+$ ;  $^1H$ -NMR (400 MHz, DMSO- $d_6$ )  $\delta$  ppm 1.66-1.94 (m, 2H) 2.89-3.00 (m, 1H) 3.14-3.23 (m, 1H) 3.23-3.42 (m, 3H) 4.20 (br. s, 1H) 4.88 (br. s, 1H)

## 284

7.34 (d,  $J$ =8.60 Hz, 2H) 7.47 (dd,  $J$ =9.78, 5.47 Hz, 1H) 7.81-7.90 (m, 2H) 8.05 (d,  $J$ =2.35 Hz, 1H) 8.62-8.79 (m, 2H) 8.81 (d,  $J$ =2.35 Hz, 1H) 10.17 (s, 1H).

## Example 281

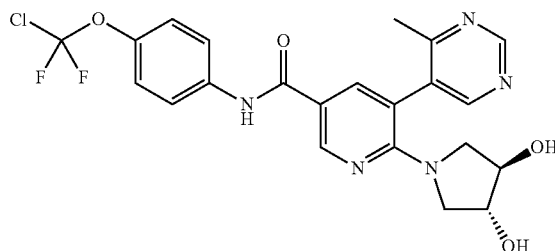
6-(5-(2-Hydroxyethyl)hexahydropyrrolo[3,4-c]pyrrol-2(1H)-yl)-5-(pyrimidin-5-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide



To a solution of 6-chloro-5-(pyrimidin-5-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide (Stage 223.1, 100 mg, 0.253 mmol) in DMF (2 mL) were added  $K_2CO_3$  (105 mg, 0.760 mmol) and tert-butyl hexahydropyrrolo[3,4-c]pyrrole-2(1H)-carboxylate (81 mg, 0.380 mmol). The RM was stirred at 110° C. for 4 h and then at 130° C. for 5 h. After removal of solvent under reduced pressure, the crude intermediate was treated with a mixture of TFA/DCM (1 mL/2 mL) at RT for 5 h. The solvent was evaporated off under reduced pressure to afford 6-(hexahydropyrrolo[3,4-c]pyrrol-2(1H)-yl)-5-(pyrimidin-5-yl)-N-(4-(trifluoromethoxy)phenyl)nicotinamide, a portion of which (100 mg, 0.213 mmol) was dissolved in anhydrous THF (2 mL) and was treated with  $KOtBu$  (71.6 mg, 0.638 mmol) and 2-bromoethanol (0.1 mL, 1.435 mmol). The RM was stirred at 70° C. overnight, the solvent was evaporated off under reduced pressure and the crude material was purified by preparative HPLC. The compound was lyophilized in water/MeCN to afford the title product. UPLC-MS (Condition 3),  $t_R$ =0.77 min,  $m/z$ =515.2  $[M+H]^+$ .

## Example 282

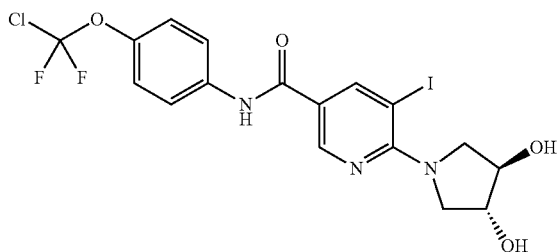
N-(4-(Chlorodifluoromethoxy)phenyl)-6-((3R,4R)-3,4-dihydroxypyrrolidin-1-yl)-5-(4-methylpyrimidin-5-yl)nicotinamide



## 285

N-(4-(chlorodifluoromethoxy)phenyl)-6-((3R,4R)-3,4-dihydroxypyrrolidin-1-yl)-5-iodonicotinamide (Stage 282.1, 100 mg, 0.190 mmol) and 4-methyl-5-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)pyrimidine (Stage 297.1, 62.8 mg, 0.285 mmol), Pd(Ph<sub>3</sub>P)<sub>4</sub> (21.98 mg, 0.019 mmol) and K<sub>2</sub>CO<sub>3</sub> (79 mg, 0.571 mmol) were added to a vial and flushed with argon. DMF (2 mL) was added and the mixture was stirred at 100° C. for 2 h. The solvent was evaporated off under reduced pressure. The crude product was dissolved in MeOH, filtered through a PL-resin Si-Thiol cartridge, the cartridge was washed with MeOH and the solvent was evaporated off under reduced pressure to give a residue which was purified by preparative HPLC (Condition 14-25% to 55% MeCN in 20 min) and followed by preparative SFC (Column Diol, from 20% to 25% in 6 min). The purified product was lyophilized in water/min vol. MeCN to afford the title product as a white powder. UPLC-MS (Condition 3), t<sub>R</sub>=0.86 min, m/z=492.2/494.2 [M+H]<sup>+</sup>.

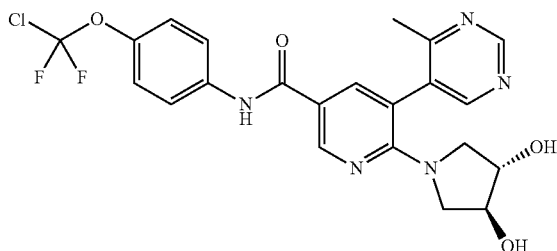
Stage 282.1 N-(4-(Chlorodifluoromethoxy)phenyl)-6-((3R,4R)-3,4-dihydroxypyrrolidin-1-yl)-5-iodonicotinamide



To a solution of 6-chloro-N-(4-(chlorodifluoromethoxy)phenyl)-5-iodonicotinamide (Stage 247.2, 300 mg, 0.654 mmol) and (3R,4R)-pyrrolidine-3,4-diol (88 mg, 0.850 mmol) in iPrOH (5 mL) was added DIPEA (0.228 mL, 1.307 mmol). The RM was stirred at 140° C. for 1 h and then 3 h at 130° C. The solvent was evaporated off under reduced pressure to give the crude product which was used directly without any further purification. UPLC-MS (Condition 3), t<sub>R</sub>=1.00 min, m/z=525.9/528.0 [M+H]<sup>+</sup>.

## Example 283

N-(4-(Chlorodifluoromethoxy)phenyl)-6-((3S,4S)-3,4-dihydroxypyrrolidin-1-yl)-5-(4-methylpyrimidin-5-yl)nicotinamide

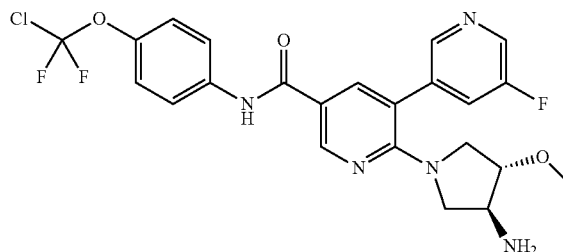


## 286

The title compound was prepared in an analogous fashion to that described in Example 290 using 5-bromo-N-(4-(chlorodifluoromethoxy)phenyl)-6-((3S,4S)-3,4-dihydroxypyrrolidin-1-yl)nicotinamide and (3S,4S)-pyrrolidine-3,4-diol to afford a white solid. HPLC (Condition 10) t<sub>R</sub>=5.517 min, UPLC-MS (Condition 3) t<sub>R</sub>=0.88 min, m/z=492.1 [M+H]<sup>+</sup>; <sup>1</sup>H-NMR (400 MHz, DMSO-d<sub>6</sub>) δ ppm 2.16 (s, 3H) 2.96 (br. s, 2H) 3.19-3.37 (m, 2H) 3.86 (br. s, 2H) 5.07 (br. s, 1H) 5.75 (br. s, 1H) 7.34 (d, J=7.43 Hz, 2H) 7.86 (d, J=7.82 Hz, 2H) 7.94-8.10 (m, 1H) 8.29-9.13 (m, 3H) 10.05-10.25 (m, 1H).

## Example 284

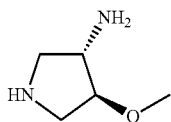
2-(trans-3-Amino-4-methoxypyrrolidin-1-yl)-N-(4-(chlorodifluoromethoxy)phenyl)-5'-fluoro-[3,3'-bipyridine]-5-carboxamide



2-Chloro-N-(4-(chlorodifluoromethoxy)phenyl)-5'-fluoro-[3,3'-bipyridine]-5-carboxamide (Stage 266.1, 70 mg, 0.160 mmol) and DIPEA (0.196 mL, 1.121 mmol) were added to a vial containing iPrOH (1 mL) and trans-4-methoxypyrrolidin-3-amine dihydrochloride (Stage 284.1, 32.5 mg, 0.168 mmol) was added under argon atmosphere. The RM was stirred at 110° C. for 40 h. The RM was treated with sat. aq. Na<sub>2</sub>CO<sub>3</sub> (20 mL) and extracted with EtOAc. The combined extracts were washed with brine (10 mL), dried over Na<sub>2</sub>SO<sub>4</sub>, filtered and the filtrate was evaporated off under reduced pressure to give the crude product which was purified by preparative HPLC (Condition 14). Fractions containing product were treated with sat. aq. Na<sub>2</sub>CO<sub>3</sub> and the MeCN was evaporated off under reduced pressure. The aq. phase was extracted with EtOAc. The combined organic layers were dried over Na<sub>2</sub>SO<sub>4</sub>, filtered and the filtrate was evaporated off under reduced pressure to give a residue which was suspended in DCM/n-hexane. The obtained solid was filtered off, washed with n-hexane and dried to afford the title product as a white solid. HPLC (Condition 10) t<sub>R</sub>=6.11 min, UPLC-MS (Condition 3) t<sub>R</sub>=0.86 min, m/z=508.2/510.1 [M+H]<sup>+</sup>; <sup>1</sup>H-NMR (400 MHz, DMSO-d<sub>6</sub>) δ ppm 1.63 (br. s, 2H) 2.83-2.90 (m, 1H) 3.03-3.11 (m, 1H) 3.20-3.22 (m, 3H) 3.27-3.35 (m, 2H) 3.48-3.56 (m, 2H) 7.34 (d, J=8.21 Hz, 2H) 7.80-7.90 (m, 3H) 8.08 (d, J=2.35 Hz, 1H) 8.51 (s, 1H) 8.60 (d, J=2.74 Hz, 1H) 8.75-8.80 (m, 1H) 10.18 (s, 1H).

## 287

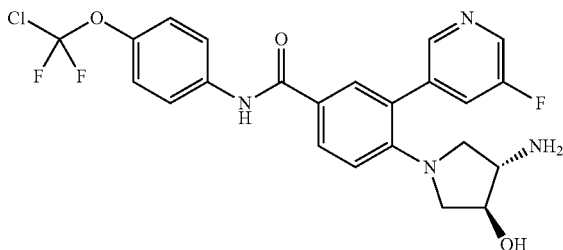
Stage 284.1 trans-4-Methoxypyrrolidin-3-amine dihydrochloride



The title compound was prepared in an analogous fashion to that described in Stage 245.2 using tert-butyl trans-3-amino-4-methoxy-1-pyrrolidinecarboxylate hydrochloride.

## Example 285

4-((3S,4S)-3-Amino-4-hydroxypyrrolidin-1-yl)-N-(4-(chlorodifluoromethoxy)phenyl)-3-(5-fluoropyridin-3-yl)benzamide



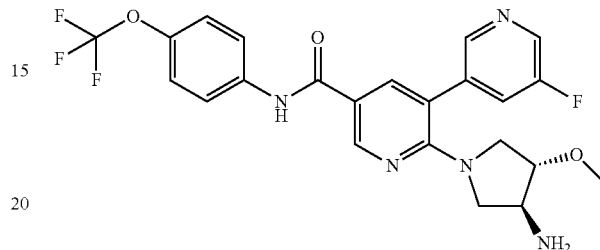
4-((3S,4S)-3-Amino-4-hydroxypyrrolidin-1-yl)-3-bromo-N-(4-(chlorodifluoromethoxy)phenyl)benzamide (Stage 245.1, 60 mg, 0.122 mmol), 3-fluoropyridine-5-boronic acid pinacol ester and  $\text{Na}_2\text{CO}_3$  (0.183 mL, 0.366 mmol) were added to a vial containing DME (1 mL) under an argon atmosphere.  $\text{PdCl}_2(\text{dppf})\cdot(\text{CH}_2\text{Cl}_2)$  (5.98 mg, 7.33  $\mu\text{mol}$ ) was added and the RM was stirred at 80° C. for 1.5 h. The RM was filtered through Hyflo® and the solvent was evaporated off under reduced pressure to give the crude product which was purified by flash chromatography (Silica gel column, DCM/MeOH, from 98:2 to 8:2). Fractions containing product were combined and the solvent was evaporated off under reduced pressure to give a residue which was suspended in DCM/n-hexane, filtered, washed with n-hexane and were purified by preparative HPLC (Condition 14). Fractions containing pure product were combined, treated with sat. aq.  $\text{Na}_2\text{CO}_3$  and the MeCN was evaporated off under reduced pressure. The aq. residue was extracted with EtOAc. The combined extracts were washed with brine, dried over  $\text{Na}_2\text{SO}_4$ , filtered and the filtrate was evaporated off under reduced pressure to give a residue which was suspended in DCM/n-hexane 1:5 and filtered to afford the title product as a white solid. HPLC (Condition 10)  $t_R$ =6.01 min, UPLC-MS (Condition 3)  $t_R$ =0.84 min,  $m/z$ =493.1/495.2  $[\text{M}+\text{H}]^+$ ;  $^1\text{H}$ -NMR (400 MHz,  $\text{DMSO}-d_6$ )  $\delta$  ppm 1.61 (br. s, 2H) 2.63-2.74 (m, 2H) 3.12 (br. s, 1H) 3.22-3.31 (m, 2H) 3.74 (br. s, 1H) 4.98 (d,  $J$ =3.52 Hz, 1H) 6.93 (d,  $J$ =8.60 Hz, 1H) 7.33 (d,

## 288

$J$ =8.99 Hz, 2H) 7.78 (d,  $J$ =9.77 Hz, 1H) 7.86 (m,  $J$ =9.00 Hz, 3H) 7.92 (dd,  $J$ =8.80, 2.15 Hz, 1H) 8.50 (s, 1H) 8.56 (d,  $J$ =2.74 Hz, 1H) 10.10 (s, 1H).

## Example 286

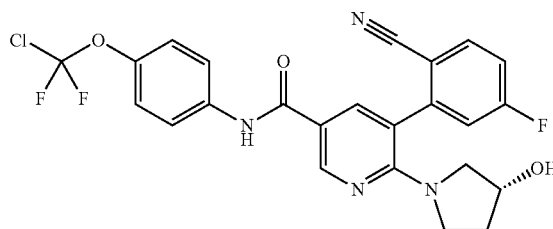
2-(trans-3-Amino-4-methoxypyrrolidin-1-yl)-5'-fluoro-N-(4-(trifluoromethoxy)phenyl)-[3,3'-bipyridine]-5-carboxamide



The title compound was prepared in an analogous fashion to that described in Example 284 using 2-chloro-5'-fluoro-N-(4-(trifluoromethoxy)phenyl)-[3,3'-bipyridine]-5-carboxamide (Stage 236.1) and trans-4-methoxypyrrolidin-3-amine dihydrochloride (Stage 284.1, 20 h at 80° C. then 24 h at 100° C.). HPLC (Condition 10)  $t_R$ =5.97 min, UPLC-MS (Condition 3)  $t_R$ =0.83 min,  $m/z$ =492.2  $[\text{M}+\text{H}]^+$ ;  $^1\text{H}$ -NMR (400 MHz,  $\text{DMSO}-d_6$ )  $\delta$  ppm 1.62 (br. s, 2H) 2.82-2.90 (m, 1H) 3.02-3.11 (m, 1H) 3.21 (s, 3H) 3.26-3.34 (m, 2H) 3.47-3.57 (m, 2H) 7.35 (d,  $J$ =8.99 Hz, 2H) 7.85 (m,  $J$ =9.00 Hz, 3H) 8.08 (d,  $J$ =2.35 Hz, 1H) 8.51 (s, 1H) 8.60 (d,  $J$ =2.74 Hz, 1H) 8.77 (d,  $J$ =1.95 Hz, 1H) 10.17 (s, 1H).

## Example 287

(R)-N-(4-(Chlorodifluoromethoxy)phenyl)-5-(2-cyano-5-fluorophenyl)-6-(3-hydroxypyrrolidin-1-yl)nicotinamide



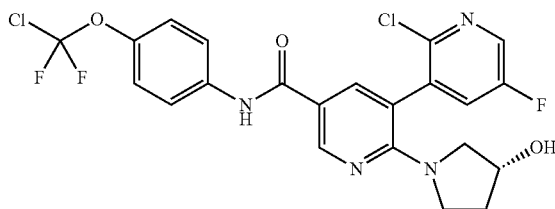
(R)-5-Bromo-N-(4-(chlorodifluoromethoxy)phenyl)-6-(3-hydroxypyrrolidin-1-yl)nicotinamide (Stage 171.1, 50 mg, 0.108 mmol), 4-fluoro-2-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)benzonitrile (32 mg, 0.130 mmol),  $\text{PdCl}_2(\text{dppf})$  (7.91 mg, 10.81  $\mu\text{mol}$ ) and  $\text{K}_3\text{PO}_4$  (68.8 mg, 0.324 mmol) were added to a vial and flushed with argon. Dioxane (1 mL) was added and the mixture was stirred at 120° C. for 1.5 h. The solvent was evaporated off under reduced pressure and the crude product was purified by preparative SFC (Column 2-EP, from 17% to 22% in 6 min). The purified product was lyophilized in water/min. vol. MeCN to afford the title

## 289

product as a slightly yellow powder. UPLC-MS (Condition 3),  $t_R=1.09$  min,  $m/z=503.1/505.2$   $[M+H]^+$ .

## Example 288

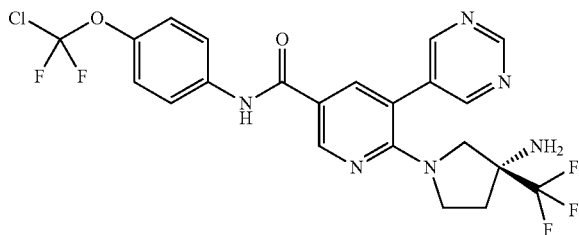
(R)-2'-Chloro-N-(4-(chlorodifluoromethoxy)phenyl)-5'-fluoro-2-(3-hydroxypyrrolidin-1-yl)-[3,3'-bipyridine]-5-carboxamide



The title compound was prepared in an analogous fashion to that described in Example 287 using (R)-5-bromo-N-(4-(chlorodifluoromethoxy)phenyl)-6-(3-hydroxypyrrolidin-1-yl)nicotinamide (Stage 171.1) and 2-chloro-5-fluoro-3-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)pyridine to afford a slightly rose powder. UPLC-MS (Condition 3),  $t_R=1.09$  min,  $m/z=513.2/515.1$   $[M+H]^+$ ;  $^1H$ -NMR (600 MHz, DMSO- $d_6$ )  $\delta$  ppm 1.67-1.96 (m, 2H) 2.86-3.50 (m, 4H) 4.14-4.29 (m, 1H) 7.33 (d,  $J=8.78$  Hz, 2H) 7.85 (d,  $J=9.15$  Hz, 2H) 7.97-8.02 (m, 1H) 8.02-8.21 (m,  $J=8.42$ , 2.93 Hz, 1H) 8.55 (t,  $J=3.11$  Hz, 1H) 8.81 (dd,  $J=7.68$ , 2.20 Hz, 1H) 10.17 (s, 1H).

## Example 289

(R)-6-(3-Amino-3-(trifluoromethyl)pyrrolidin-1-yl)-N-(4-(chlorodifluoromethoxy)phenyl)-5-(pyrimidin-5-yl)nicotinamide



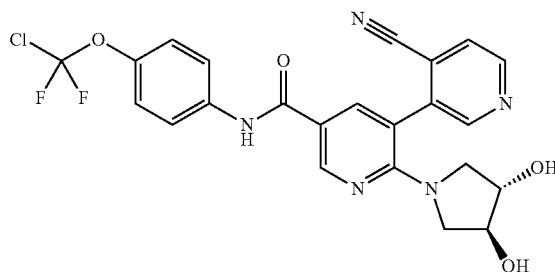
A stirred mixture of 6-chloro-N-(4-(chlorodifluoromethoxy)phenyl)-5-(pyrimidin-5-yl)nicotinamide (Stage 247.1, 150 mg, 0.365 mmol) in iPrOH (0.5 mL) was treated with tert-butyl[3-(trifluoromethyl)pyrrolidine-3-yl]carbamate (179 mg, 0.547 mmol) and DIPEA (0.159 mL, 0.912 mmol) were added at RT. The resulting mixture was stirred at 140° C. for 12 h. The solution was diluted in EtOAc (50 mL), washed with a 2 N citric acid solution (20 mL), aq. sat. solution of  $NaHCO_3$  (20 mL) and brine (20 mL), dried over  $Na_2SO_4$ , filtered and the solvent was evaporated off under reduced pressure to give the crude product which was purified by flash chromatography (RediSep® Silica gel column, 40 g, DCM/MeOH 95:5). Obtained (R)-tert-butyl (1-(5-((4-(chlorodifluoromethoxy)phenyl)carbamoyl)-3-(pyrimidin-5-yl)

## 290

pyridin-2-yl)-3-(trifluoromethyl)pyrrolidin-3-yl)carbamate (137 mg, 0.196 mmol) was suspended in DCM (1 mL) and TFA (0.453 mL, 5.88 mmol) was added at RT. The resulting light yellow solution was stirred for 1.5 h at RT. The RM was diluted with EtOAc (50 mL), then washed with an aq. sat. solution of  $NaHCO_3$  and twice with water (2×20 mL). The aqueous phase was extracted with EtOAc (40 mL). The combined organic phases were dried over sodium sulfate, filtered and concentrated under reduced pressure. The crude product was purified by flash chromatography (RediSep® Silica gel, 12 g, DCM/MeOH 95:5). The obtained residue re-suspended in MeOH (2 mL) was stirred at RT for 15 min. The crystals were filtered and washed with MeOH (2 mL) to afford the title product as a white solid. HPLC (Condition 10)  $t_R=5.92$  min, UPLC-MS (Condition 3)  $t_R=1.05$  min,  $m/z=529.2$   $[M+H]^+$ ;  $^1H$ -NMR (400 MHz, DMSO- $d_6$ )  $\delta$  ppm 1.76-1.85 (m, 1H) 2.02 (s, 1H) 2.24-2.35 (m, 2H) 3.13-3.27 (m, 2H) 3.37-3.52 (m, 2H) 7.35 (d,  $J=8.60$  Hz, 2H) 7.86 (m,  $J=9.00$  Hz, 2H) 8.14 (d,  $J=2.35$  Hz, 1H) 8.81 (d,  $J=2.35$  Hz, 1H) 8.92 (s, 2H) 9.22 (s, 1H) 10.23 (s, 1H).

## Example 290

N-(4-(Chlorodifluoromethoxy)phenyl)-4'-cyano-2-((3S,4S)-3,4-dihydroxypyrrolidin-1-yl)-[3,3'-bipyridine]-5-carboxamide



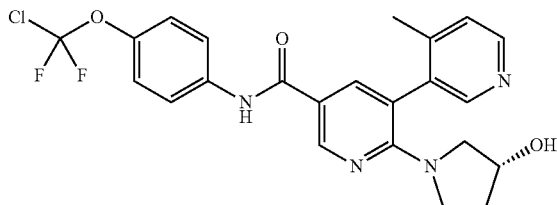
4-Cyanopyridine-3-boronic acid pinacol ester (192 mg, 0.836 mmol),  $K_2CO_3$  (0.418 mL, 0.836 mmol) and  $Pd(PPh_3)_4$  (24.14 mg, 0.021 mmol) were added to a solution of 5-bromo-N-(4-(chlorodifluoromethoxy)phenyl)-6-((3S,4S)-3,4-dihydroxypyrrolidin-1-yl)nicotinamide (Stage 248.1, 200 mg, 0.418 mmol) in DMF (2.5 mL) in a vial at RT. The vial was evacuated/purged with argon, sealed and heated at 130° C. for 18 h. The RM was diluted with EtOAc (60 mL) and washed with an aq. sat. solution of  $NaHCO_3$  (20 mL) and brine (2×20 mL). The organic phase was dried over  $Na_2SO_4$ , filtered and the solvent was evaporated off under reduced pressure. The resulting residue was suspended in MeOH (3 mL), stirred for at RT 15 min, filtered and washed with MeOH (2 mL). The filtrate was filtered through a SPE PL-Thiol cartridge (StratoSpheres™, 500 mg, nominal:1.5 mmol) and the solvent was evaporated off under reduced pressure to give a residue which was purified by preparative SFC (Column 2-EP, from 21% to 26% in 6 min) to afford the title product as a yellow solid. HPLC (Condition 10)  $t_R=5.90$  min, UPLC-MS (Condition 3)  $t_R=0.94$  min,  $m/z=502.2$   $[M+H]^+$ ;  $^1H$ -NMR (400 MHz, DMSO- $d_6$ )  $\delta$  ppm 2.95 (d,  $J=11.34$  Hz, 2H) 3.14-3.39 (m, 2H) 3.86 (br. s, 2H) 5.02-5.07 (m, 1H) 5.09-5.14 (m, 1H) 7.34 (d,

## 291

J=8.60 Hz, 2H) 7.86 (d, J=8.60 Hz, 2H) 7.96-8.06 (m, 1H) 8.12 (d, J=17.60 Hz, 1H) 8.76-8.88 (m, 2H) 9.08 (br. s, 1H) 10.21 (d, J=4.69 Hz, 1H).

## Example 291

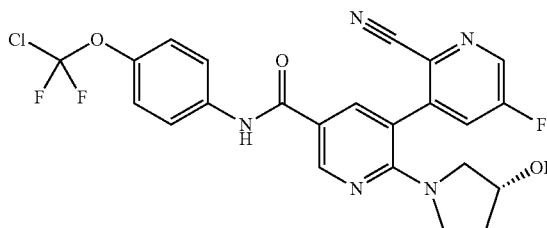
(R)—N-(4-(Chlorodifluoromethoxy)phenyl)-2-(3-hydroxypyrrolidin-1-yl)-4'-methyl-[3,3'-bipyridine]-5-carboxamide



(R)-5-Bromo-N-(4-(chlorodifluoromethoxy)phenyl)-6-(3-hydroxypyrrolidin-1-yl)nicotinamide (Stage 171.1, 70 mg, 0.151 mmol), 4-methyl-3-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)pyridine (49.7 mg, 0.227 mmol), Pd(Ph<sub>3</sub>P)<sub>4</sub> (17.48 mg, 0.015 mmol) and K<sub>3</sub>PO<sub>4</sub> (96 mg, 0.454 mmol) were added to a vial, flushed with argon, treated with toluene (1 mL), and stirred at 110° C. for 2 h followed by 4 h at 130° C. Dioxane (1 mL) was added and the RM was stirred for an additional 3 days at 130° C. The RM was diluted with dioxane and filtered on a pad of Hyflo®, followed by Si-Thiol scavenger treatment. The solvent was evaporated off under reduced pressure and the crude product was purified by preparative SFC (Column Diol, from 20% to 25% in 6 min). The purified product was lyophilized in water/min. vol. MeCN to afford the title product as an off-white powder. UPLC-MS (Condition 3), t<sub>R</sub>=0.97 min, m/z=475.1/477.1 [M+H]<sup>+</sup>; <sup>1</sup>H-NMR (600 MHz, DMSO-d<sub>6</sub>) δ ppm 1.62-1.89 (m, 2H) 2.02/2.14 (s, 3H) 2.70-3.35 (m, 4H) 4.09-4.24 (m, 1H) 4.79-4.96 (m, 1H) 7.27-7.42 (m, J=8.66 Hz, 3H) 7.86 (d, J=7.91 Hz, 2H) 7.91-8.00 (m, 1H) 8.41-8.61 (m, 2H) 8.77 (br. s, 1H) 10.11-10.19 (m, 1H).

## Example 292

(R)—N-(4-(Chlorodifluoromethoxy)phenyl)-2'-cyano-5'-fluoro-2-(3-hydroxypyrrolidin-1-yl)-[3,3'-bipyridine]-5-carboxamide



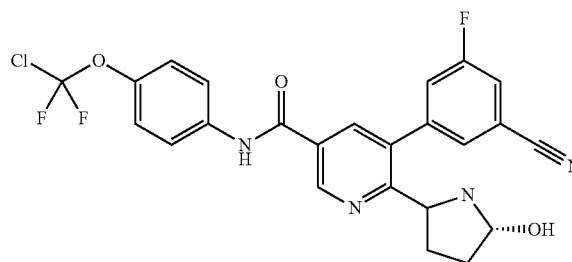
(R)-2'-Chloro-N-(4-(chlorodifluoromethoxy)phenyl)-5'-fluoro-2-(3-hydroxypyrrolidin-1-yl)-[3,3'-bipyridine]-5-carboxamide (Example 288, 100 mg, 0.195 mmol), Pd(Ph<sub>3</sub>P)<sub>4</sub>

## 292

(22.51 mg, 0.019 mmol), zinc cyanide (114 mg, 0.974 mmol) were added to a vial, flushed with argon, treated with DMF (2 mL) and stirred for 18 h at 130° C. The solvent was evaporated off under reduced pressure and the residue was purified by preparative SFC (Column NH<sub>2</sub>, from 16% to 21% in 6 min). The fractions containing product were combined and the solvent was evaporated off under reduced pressure to give a residue which was lyophilized in water/min. vol. MeCN to afford the title product as an off-white powder. UPLC-MS (Condition 3), t<sub>R</sub>=1.09 min, m/z=504.1/506.1 [M+H]<sup>+</sup>; <sup>1</sup>H-NMR (600 MHz, DMSO-d<sub>6</sub>) δ ppm 1.70-1.97 (m, 2H) 2.80-2.94 (m, 1H) 3.09-3.23 (m, 1H) 3.23-3.38 (m, 2H) 4.16-4.29 (m, 1H) 4.85-5.02 (m, 1H) 7.35 (d, J=8.47 Hz, 2H) 7.86 (d, J=8.28 Hz, 2H) 8.08-8.37 (m, 2H) 8.86 (d, J=6.96 Hz, 2H) 10.24 (br. s, 1H).

## Example 293

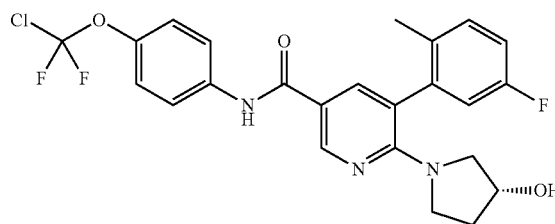
(R)—N-(4-(Chlorodifluoromethoxy)phenyl)-5-(3-cyano-5-fluorophenyl)-6-(3-hydroxypyrrolidin-1-yl)nicotinamide



The title compound was prepared in an analogous fashion to that described in Example 290 using (R)-5-bromo-N-(4-(chlorodifluoromethoxy)phenyl)-6-(3-hydroxypyrrolidin-1-yl)nicotinamide (Stage 171.1) and 3-Cyano-5-Fluorophenylboronic acid to afford a white solid. HPLC (Condition 10) t<sub>R</sub>=6.383 min, UPLC-MS (Condition 11) m/z=503.1 [M+H]<sup>+</sup>; <sup>1</sup>H-NMR (400 MHz, DMSO-d<sub>6</sub>) δ ppm 1.69-1.80 (m, 1H) 1.81-1.93 (m, 1H) 2.86 (d, J=10.95 Hz, 1H) 3.14-3.29 (m, 2H) 3.35-3.49 (m, 1H) 4.21 (br. s, 1H) 4.87 (d, J=3.52 Hz, 1H) 7.34 (d, J=8.60 Hz, 2H) 7.67 (d, J=9.38 Hz, 1H) 7.79 (s, 1H) 7.83-7.91 (m, J=8.99 Hz, 3H) 8.06 (d, J=1.96 Hz, 1H) 8.77 (d, J=2.35 Hz, 1H) 10.17 (s, 1H).

## Example 294

(R)—N-(4-(Chlorodifluoromethoxy)phenyl)-5-(5-fluoro-2-methylphenyl)-6-(3-hydroxypyrrolidin-1-yl)nicotinamide

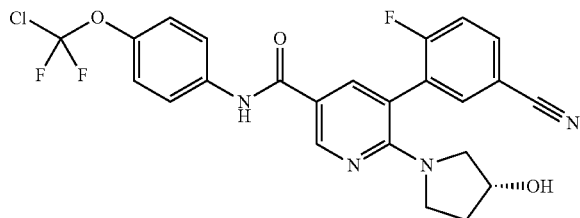


## 293

The title compound was prepared in an analogous fashion to that described in Example 290 using (R)-5-bromo-N-(4-(chlorodifluoromethoxy)phenyl)-6-(3-hydroxypyrrolidin-1-yl)nicotinamide (Stage 171.1) and 5-Fluoro-2-methylphenylboronic acid to afford a white solid. HPLC (Condition 10)  $t_R$ =6.424 min, UPLC-MS (Condition 11)  $m/z$ =492.1 [M+H]<sup>+</sup>; <sup>1</sup>H-NMR (400 MHz, DMSO-*d*<sub>6</sub>)  $\delta$  ppm 1.60-1.92 (m, 2H) 1.94-2.11 (m, 3H) 2.78-3.03 (m, 1H) 3.07-3.28 (m, 3H) 4.11-4.23 (m, 1H) 4.76-4.94 (m, 1H) 7.10-7.19 (m, 1H) 7.23-7.31 (m, 1H) 7.33 (d, *J*=8.99 Hz, 3H) 7.86 (d, *J*=8.99 Hz, 2H) 7.91 (m, *J*=2.30 Hz, 1H) 8.73-8.79 (m, 1H) 10.08-10.17 (m, 1H).

## Example 295

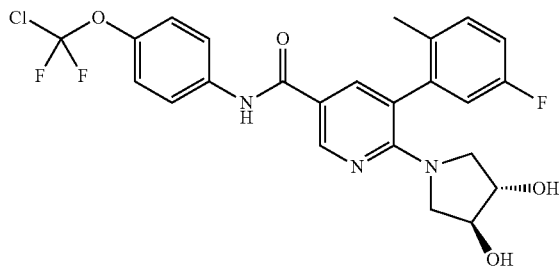
(R)-N-(4-(Chlorodifluoromethoxy)phenyl)-5-(5-cyano-2-fluorophenyl)-6-(3-hydroxypyrrolidin-1-yl)nicotinamide



5-Cyano-2-fluorophenylboronic acid (53.5 mg, 0.324 mmol), K<sub>3</sub>PO<sub>4</sub> (138 mg, 0.648 mmol) and PdCl<sub>2</sub>(dppf)-(CH<sub>2</sub>Cl<sub>2</sub>) (17.65 mg, 0.022 mmol) were added to (R)-5-bromo-N-(4-(chlorodifluoromethoxy)phenyl)-6-(3-hydroxypyrrolidin-1-yl)nicotinamide (Stage 171.1.) in dioxane (1.5 mL) in a vial at RT. The vial was evacuated/purged with argon, sealed and stirred at 130° C. for 2.5 h. The RM was diluted with EtOAc (60 mL), washed with an aq. sat. solution of NaHCO<sub>3</sub> (20 mL) and brine (2×20 mL). The organic phase was dried over Na<sub>2</sub>SO<sub>4</sub>, filtered, and the solvent was evaporated off under reduced pressure. The residue was dissolved in MeOH (3 mL), filtered through a SPE PL-Thiol cartridge (StratoSpheres™, 500 mg, nominal:1.5 mmol), the cartridge was washed with MeOH and the solvent was evaporated off under reduced pressure to give a residue which was purified by preparative SFC (Column 2-EP, from 18% to 23% in 6 min) to afford the title product as a white solid. HPLC (Condition 10)  $t_R$ =6.31 min, UPLC-MS (Condition 3)  $t_R$ =1.12 min,  $m/z$ =503.1 [M+H]<sup>+</sup>; <sup>1</sup>H-NMR (400 MHz, DMSO-*d*<sub>6</sub>)  $\delta$  ppm 1.64-2.01 (m, 2H) 2.93 (br. s, 1H) 3.19 (dd, *J*=11.14, 4.11 Hz, 1H) 3.23-3.43 (m, 2H) 4.21 (br. s, 1H) 4.84 (br. s, 1H) 7.34 (d, *J*=8.99 Hz, 3H) 7.57 (br. s, 1H) 7.80-7.91 (m, 3H) 7.94-8.24 (m, 4H) 8.79 (d, *J*=1.96 Hz, 1H) 10.16 (s, 1H).

## Example 296

N-(4-(Chlorodifluoromethoxy)phenyl)-6-((3S,4S)-3,4-dihydroxypyrrolidin-1-yl)-5-(5-fluoro-2-methylphenyl)nicotinamide

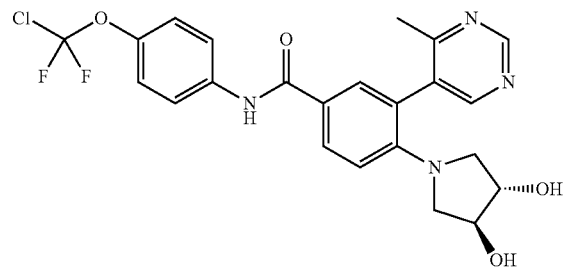


## 294

The title compound was prepared in an analogous fashion to that described in Example 290 using 5-bromo-N-(4-(chlorodifluoromethoxy)phenyl)-6-((3S,4S)-3,4-dihydroxypyrrolidin-1-yl)nicotinamide (Stage 248.1) and 5-fluoro-2-methylphenylboronic acid to afford a white solid. HPLC (Condition 10)  $t_R$ =6.25 min, UPLC-MS (Condition 11)  $t_R$ =1.08 min,  $m/z$ =508.1 [M+H]<sup>+</sup>; <sup>1</sup>H-NMR (400 MHz, DMSO-*d*<sub>6</sub>)  $\delta$  ppm 1.59-1.90 (s, 2H) 1.95/2.06 (s, 3H) 2.76-3.00 (m, 1H) 3.04-3.25 (m, 2H) 4.09-4.21 (m, 1H) 4.76-4.90 (m, 2H) 7.08-7.17 (m, 1H) 7.25-7.35 (m, 4H) 7.81-7.97 (m, 3H) 8.74 (s, 1H) 10.07-10.17 (m, 1H).

## Example 297

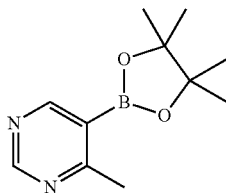
N-(4-(Chlorodifluoromethoxy)phenyl)-4-((3S,4S)-3,4-dihydroxypyrrolidin-1-yl)-3-(4-methylpyrimidin-5-yl)benzamide



4-Methyl-5-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)pyrimidine (Stage 297.1, 94 mg, 0.429 mmol), K<sub>2</sub>CO<sub>3</sub> (118 mg, 0.857 mmol) and Pd(PPh<sub>3</sub>)<sub>4</sub> (33.0 mg, 0.029 mmol) were added to a solution of 3-bromo-N-(4-(chlorodifluoromethoxy)phenyl)-4-((3S,4S)-3,4-dihydroxypyrrolidin-1-yl)benzamide (Stage 244.1, 150 mg, 0.286 mmol) in DMF (2.5 mL). at RT in a vial. The vial was evacuated/purged with argon, sealed and stirred at 130° C. for 2 h. The RM was diluted in EtOAc (80 mL), washed with water (3×30 mL), dried over Na<sub>2</sub>SO<sub>4</sub>, filtered, and the solvent was evaporated off under reduced pressure. The residue was dissolved in methanol (3 mL) and filtered through a SPE PL-Thiol cartridge (StratoSpheres™, 500 mg, nominal:1.5 mmol), the cartridge was washed with MeOH and the solvent was evaporated off under reduced pressure to give a residue which was purified by preparative SFC (Column 2-EP, from 20% to 25% in 6 min) and by preparative HPLC. The obtained residue was treated with a aq. solution of Na<sub>2</sub>CO<sub>3</sub> (3 mL) and extracted twice with EtOAc (2×30 mL). The combined organic phases were washed with water (2×15 mL), dried over Na<sub>2</sub>SO<sub>4</sub>, filtered, and the solvent was evaporated off under reduced pressure to afford the title product as a beige solid. HPLC (Condition 10)  $t_R$ =6.091 min, UPLC-MS (Condition 11)  $t_R$ =0.93 min,  $m/z$ =491.1 [M+H]<sup>+</sup>; <sup>1</sup>H-NMR (400 MHz, DMSO-*d*<sub>6</sub>)  $\delta$  ppm 2.19/2.40 (s, 3H) 2.65-2.78 (m, 2H) 3.06-3.22 (m, 2H) 3.80-3.90 (m, 2H) 5.01-5.12 (m, 2H) 6.93 (d, *J*=8.99 Hz, 1H) 7.32 (d, *J*=8.60 Hz, 2H) 7.70-7.80 (m, 1H) 7.83-7.89 (d, *J*=8.60 Hz, 2H) 7.91-7.98 (m, 1H) 8.82 (s, 1H) 9.05 (s, 1H) 10.01-10.12 (m, 1H).

## 295

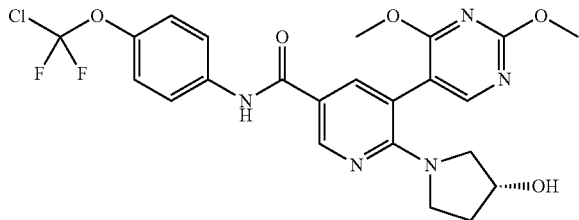
Stage 297.1 4-Methyl-5-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)pyrimidine



A mixture of 5-bromo-4-methylpyrimidine (470 mg, 2.72 mmol), PdCl<sub>2</sub>(dppf)<sub>2</sub> (199 mg, 0.272 mmol), 4,4,4',4',5,5,5',5'-octamethyl-2,2'-bi(1,3,2-dioxaborolane) (1035 mg, 4.07 mmol) and KOAc (800 mg, 8.15 mmol) in anhydrous dioxane (15 mL) was stirred overnight at 90° C. The RM was filtered through Hyflo® and the solvent was evaporated off under reduced pressure. The residue was dissolved in EtOAc, washed with brine, dried over Na<sub>2</sub>SO<sub>4</sub>, filtered and the filtrate was evaporated off under reduced pressure to afford the crude title product as a dark solid. UPLC-MS (Condition 3), t<sub>R</sub>=0.30 min, m/z=139.0 [M+H]<sup>+</sup>, 137.1 [M-H]<sup>-</sup>.

## Example 298

(R)—N-(4-(Chlorodifluoromethoxy)phenyl)-5-(2,4-dimethoxypyrimidin-5-yl)-6-(3-hydroxypyrrolidin-1-yl)nicotinamide



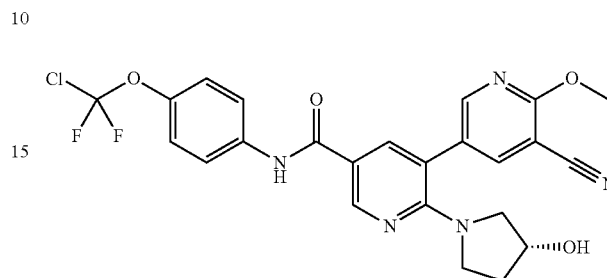
(R)-5-Bromo-N-(4-(chlorodifluoromethoxy)phenyl)-6-(3-hydroxypyrrolidin-1-yl)nicotinamide (Stage 171.1, 150 mg, 0.324 mmol), 2,4-dimethoxypyrimidin-5-ylboronic acid (71.6 mg, 0.389 mmol), PdCl<sub>2</sub>(dppf)-(CH<sub>2</sub>Cl<sub>2</sub>) (39.7 mg, 0.049 mmol) and K<sub>3</sub>PO<sub>4</sub> (206 mg, 0.973 mmol) were added to a vial and flushed with argon. Dioxane (1.5 mL) was added and the mixture was stirred at 120° C. overnight. The solvent was evaporated off under reduced pressure, the residue was treated with Si-Thiol (Biotage, load: 1.3 mmol/g) in MeOH and purified by preparative SFC (Column DEAP, from 18% to 23% in 6 min) to afford the title compound as an off-white powder after lyophilization from water/MeCN. UPLC-MS (Condition 11), t<sub>R</sub>=1.05 min, m/z=522.3/524.2 [M+H]<sup>+</sup>; <sup>1</sup>H-NMR (400 MHz, DMSO-d<sub>6</sub>) δ ppm 1.66-1.92 (m, 2H) 2.89-3.43 (m, 4H) 3.91 (br. s, 3H) 3.95 (s, 3H) 4.21 (br. s, 1H)

## 296

4.74-5.00 (m, 1H) 7.33 (d, J=8.91 Hz, 2H) 7.83-7.90 (m, 3H) 8.32 (br. s, 1H) 8.74 (d, J=2.26 Hz, 1H) 10.11 (s, 1H).

## Example 299

(R)—N-(4-(Chlorodifluoromethoxy)phenyl)-5'-cyano-2-(3-hydroxypyrrolidin-1-yl)-6'-methoxy-[3,3'-bipyridine]-5-carboxamide



The title compound was prepared in an analogous fashion to that described in Example 298 using (R)-5-bromo-N-(4-(chlorodifluoromethoxy)phenyl)-6-(3-hydroxypyrrolidin-1-yl)nicotinamide (Stage 171.1) and 2-methoxy-5-(4,4,5,5-tetramethyl-1,3,2-dioxaborolan-2-yl)nicotinonitrile to afford an off-white powder. UPLC-MS (Condition 11), t<sub>R</sub>=1.13 min, m/z=516.2/518.2 [M+H]<sup>+</sup>; <sup>1</sup>H-NMR (600 MHz, DMSO-d<sub>6</sub>) δ ppm 1.67-1.78 (m, 1H) 1.79-1.93 (m, 1H) 2.90 (d, J=11.29 Hz, 1H) 3.19-3.29 (m, 2H) 3.35-3.43 (m, 1H) 4.06 (s, 3H) 4.21 (br. s, 1H) 4.90 (br. s, 1H) 7.33 (d, J=8.66 Hz, 2H) 7.85 (d, J=8.85 Hz, 2H) 8.02 (d, J=1.88 Hz, 1H) 8.35 (s, 1H) 8.50 (s, 1H) 8.77 (d, J=1.88 Hz, 1H) 10.18 (s, 1H).

## Assays

The utility of the compounds of the invention described herein can be evidenced by testing in the following assays. Compounds of the invention were assessed for their ability to inhibit ABL1 activity in biochemical assays and BCR-ABL1 in cellular assays described below.

## Biochemical Assays

## Expression and Purification of Protein Kinase—

Expression and purification of human ABL was performed using standard expression purification procedures. The ABL64-515 protein was generated and used for in vitro kinase assays. The protein was generated by a co-expression vector carrying the DNA fragments for ABL1 (1a isoform, with an N-terminal His6-tag followed by a PreScission protease cleavage site) and the human protein tyrosine phosphatase-1B (residues 1-283, untagged), using the dual expression vector pCDF Duet-1 (Novagen). The His-ABL was expressed in *E. coli* BL21 (DE3) and the ABL proteins were isolated by Ni-affinity on a Ni-NTA column (Qiagen). The His-tag was removed by PreScission protease (GE Healthcare) and the non-phosphorylated ABL further purified on a Mono Q HR 10/10 (GE Healthcare, mono-phosphorylated ABL is about 10-20% of total ABL protein) and HiLoad 16/60 Superdex 200 size exclusion column (GE Healthcare). Non-phosphorylated ABL64-515 proteins were analyzed by mass spectroscopic analysis and flash-frozen in aliquots and stored at -80° C. SRC (amino acids 83-535 or Src83-535) was expressed and purified as described (S. W.

Cowan-Jacob, G. Fendrich, P. W. Manley, W. Jahnke, D. Fabbro, J. Liebetanz, T. Meyer, c-Src crystal structure provides insights into c-Src activation. *Structure* 13 (2005) 861-871).

#### Radio ABL1 (64-515) Assay

For determination of ABL kinase activity, the radiometric filter-binding assay was used. The assay was performed by mixing 10  $\mu$ L of the compound pre-diluted with 10  $\mu$ L of ATP (20  $\mu$ M ATP with 0.1  $\mu$ Ci [ $\gamma$ -<sup>33</sup>P]-ATP) with the phospho-acceptor peptide poly[Ala6Glu2LysHBr5Tyr1]=polyAEKY) in 20 mM Tris/HCl pH 7.5, 1 mM DTT, 10 mM MgCl<sub>2</sub>, 0.01 mM Na<sub>3</sub>VO<sub>4</sub>, 50 mM NaCl. 10  $\mu$ L of enzyme (ranging between 5 nM to 20 nM) was added to initiate the reaction. Pre-incubation of enzyme with compounds (when stated) was performed by exposing the enzyme to compounds prior to addition of the substrate mixture (ATP and/or peptide substrate). After 15 min at room temperature, the reaction was stopped by the addition of 50  $\mu$ L 125 mM EDTA, and the peptide-bound <sup>33</sup>P separated on filter-plates (PVDF or MAIP; Millipore, Volketswil, Switzerland) prepared according to the manufacturer's instructions. Filter-plates were washed 3 $\times$  with 0.5% H<sub>3</sub>PO<sub>4</sub>, followed by addition of 30  $\mu$ L scintillation cocktail (Microscint, Perkin Elmer) per well and then analysed in a TopCount NXT scintillation counter (Perkin Elmer). Results were expressed as IC<sub>50</sub> values. The K<sub>m</sub> values for ATP were determined by assaying the ABL kinase with increasing concentrations of ATP and keeping the exogenous acceptor protein substrate (poly-AEKY) at a constant concentration (at about 2-fold its K<sub>m</sub>) and vice versa. K<sub>m</sub> and V<sub>max</sub> were calculated according to Eadie-Hofstee as described (D. Fabbro, G. Fendrich, V. Guez, T. Meyer, P. Furet, J. Mestan, J. D. Griffin, P. W. Manley, S. W. Cowan-Jacob, Targeted therapy with imatinib: An exception or a rule? *Handbook of Experimental Pharmacology* 167, Inhibitors of Protein Kinases and Protein Phosphates (2005) 361-389). The data were plotted as V versus V/S, where V is the velocity of the reaction at a given substrate (S) concentration, and fitted to a straight line using linear regression analysis, where the slope of the line corresponds to -K<sub>m</sub> and the Y-intercept represents the V<sub>max</sub>.

#### Caliper ABL1 (64-515) Assay

All assays were performed in 384-well microtiter plates. Each assay plate contained 8-point serial dilutions for 40 test compounds, as well as four 8-point serial dilutions of staurosporine as a reference compound, plus 16 high and 16 low controls. Liquid handling and incubation steps were done on a Thermo CatX workstation equipped with Innovadyne Nanodrop Express. Between pipetting steps, tips were cleaned in wash cycles using wash buffer.

The assay plates were prepared by addition of 50 nL per well of compound solution in 90% DMSO. The kinase reactions were started by stepwise addition of 4.5  $\mu$ L per well of peptide/ATP-solution (50 mM HEPES, pH 7.5, 1 mM DTT, 0.02% BSA, 0.6% DMSO, 10 mM beta-glycerophosphate, and 10  $\mu$ M sodium orthovanadate, 20 mM MgCl<sub>2</sub>, 2 mM MnCl<sub>2</sub>, 4  $\mu$ M ATP, 4  $\mu$ M peptide (FITC-Ahx-EAIYAAP-FAKKK-NH<sub>2</sub>)) and 4.5  $\mu$ L per well of enzyme solution (50 mM HEPES, pH 7.5, 1 mM DTT, 0.02% BSA, 0.6% DMSO, 10 mM beta-glycerophosphate, and 10  $\mu$ M sodium orthovanadate, 20 mM MgCl<sub>2</sub>, 2 mM MnCl<sub>2</sub>, 3.5 nM ABL (ABL (64-515), produced in-house from *E. coli*)). Kinase reactions

were incubated at 30° C. for 60 minutes and subsequently terminated by addition of 16  $\mu$ L per well of stop solution (100 mM HEPES pH 7.5, 5% DMSO, 0.1% Caliper coating reagent, 10 mM EDTA, and 0.015% Brij35). Plates with terminated kinase reactions were transferred to the Caliper LC3000 workstations for reading. Phosphorylated and unphosphorylated peptides were separated using the Caliper microfluidic mobility shift technology. Briefly, samples from terminated kinase reactions were applied to the chip. Analytes are transported through the chip by constant buffer flow and the migration of the substrate peptide is monitored by the fluorescence signal of its label. Phosphorylated peptide (product) and unphosphorylated peptide (substrate) are separated in an electric field by their charge/mass ratio. Kinase activities were calculated from the amounts of formed phospho-peptide. IC<sub>50</sub> values were determined from percent inhibition values at different compound concentrations by non-linear regression analysis.

#### Preparation of Compound Dilutions:

Test compounds were dissolved in DMSO (10 mM) and transferred into 1.4 mL flat bottom or V-shaped Matrix tubes carrying a unique 2D matrix. The stock solutions were stored at +2° C. if not used immediately. For the test procedure the vials were defrosted and identified by a scanner whereby a working sheet was generated that guided the subsequent working steps.

Compound dilutions were made in 96-well plates. This format enabled the assay of maximally 40 individual test compounds at 8 concentrations (single points) including 4 reference compounds. The dilution protocol included the production of "pre-dilution plates", "master plates" and "assay plates".

#### Pre-Dilution Plates:

Polypropylene 96-well plates were used as pre-dilution plates. A total of 4 pre-dilution plates were prepared including 10 test compounds each on the plate positions A1-A10, one standard compound at A11 and one DMSO control at A12. All dilution steps were done on a HamiltonSTAR robot.

#### Master Plates:

30  $\mu$ L of individual compound dilutions including standard compound and controls of the 4 "pre-dilution plates" were transferred into a 384 "master plate" including the following concentrations 1'810, 362, 72.5, 54.6, 14.5, 2.9, 0.58 and 0.120/1, respectively in 90% of DMSO.

#### Assay Plates:

Identical "assay plates" were then prepared by pipetting 50 nL each of compound dilutions of the "master plates" into 384-well "assay plates" by means of a HummingBird 384-channel dispenser. These plates were used directly for the assay which was performed in a total volume of 9.05  $\mu$ L. This led to a final compound concentration of 10, 2.0, 0.4, 0.08, 0.016, 0.0032, 0.00064 and 0.000128  $\mu$ M and a final DMSO concentration of 0.5% in the assay.

#### Cellular Assays

To assess the ability of compounds of the invention to inhibit BCR-ABL1 activity in cellular assays, compounds were evaluated for their ability to selectively inhibit the proliferation of cells dependent on BCR-ABL1 expression relative to cells that do not depend on BCR-ABL1 expression.

The murine bone marrow-derived cell line Ba/F3 was used to generate the appropriate cell line models. Ba/F3 cells were

obtained from the German Collection of Microorganisms and Cell Cultures (DSMZ, Braunschweig and DSMZ No. ACC 300). Parental Ba/F3 cells depend on IL3 for growth and survival and were used as the reference cell line that does not depend on BCR-ABL1 activity for growth and survival. These cells are referred to as Ba/F3-WT.

To generate Ba/F3 cells that depend on BCR-ABL1 expression for growth and survival, Ba/F3 cells were engineered to express BCR-ABL1 using retroviral transduction with a MSCV based retroviral vector containing a p210 BCR-ABL1 expression cassette. When grown in the absence of IL-3, the proliferation of the cells is dependent on the expression of BCR-ABL1. (Daley, G. Q. and Baltimore, D. Transformation of an interleukin 3-dependent hematopoietic cell line by the chronic myeloid leukemia-specific p210 BCR-ABL1 protein. PNAS 1988; 85:9312-9316). These cells are referred to as Ba/F3-BCR-ABL-WT. A similar approach was used to generate Ba/F3 cells that depend on a BCR-ABL1 variant in which threonine 315 is replaced with isoleucine. These cells are referred to as Ba/F3-BCR-ABL-T315I.

Ba/F3-WT cells were maintained in RPMI1640 media with L-glutamine, HEPES (Lonza), 10% FBS (Gibco) and 5 ng/ml IL-3 (Calbiochem). Ba/F3-BCR-ABL1-WT cells and Ba/F3-BCR-ABL1-T315I cells were maintained in RPMI1640 media with L-glutamine, HEPES (Lonza) and 10% FBS (Gibco).

#### Proliferation Assay

For each cell line, the cell density was adjusted to 50 000 cells/mL and 50  $\mu$ L (2500 cells) added per well of a 384-well assay plate.

Test compounds were resuspended in DMSO at a concentration of 10 mM. A serial three-fold dilution of each compound with DMSO was performed in 384-well plates using the Janus Liquid Dispenser (PerkinElmer). Compound was delivered to the assay plates containing 2500 cells in a 50  $\mu$ L volume via Acoustic delivery from an ATS-100 (EDC). For Ba/F3-BCR-ABL1-WT cell assays, 2 nL of each compound dilution was transferred to the assay plate for final assay concentrations of 0.4  $\mu$ M, 0.13  $\mu$ M, 0.044  $\mu$ M, 0.015  $\mu$ M, 0.005  $\mu$ M, 0.001  $\mu$ M, 0.00033  $\mu$ M, 0.00011  $\mu$ M, 0.000037  $\mu$ M, 0.000012  $\mu$ M. For Ba/F3-WT and Ba/F3-BCR-ABL1-T315I cell assays, 50 nL of each compound dilution was transferred to the assay plate for final assay concentrations of 10  $\mu$ M, 3.33  $\mu$ M, 1.11  $\mu$ M, 0.37  $\mu$ M, 0.12  $\mu$ M, 0.041  $\mu$ M, 0.014  $\mu$ M, 0.0046  $\mu$ M, 0.0015  $\mu$ M, 0.00051  $\mu$ M.

Cells were incubated at 37° C. in a humidified environment with 5% carbon dioxide for 48 hours. Britelite plus solution (Perkin Elmer) was prepared according to the manufacturer's instructions and 25  $\mu$ L added to each well of the assay plate. Plates were incubated for 3-5 minutes and the luminescence detected on an EnVision Multimode plate reader (Perkin Elmer). The degree of luminescence correlates with the number of cells in each well. The effect of each inhibitor concentration can therefore be calculated and IC<sub>50</sub> values generated.

The compounds of the invention show IC<sub>50</sub> values in the range of 0.1 nM to 20 nM for inhibition of Abl kinase activity in a radiometric filter binding (Radio). For a microfluidic mobility shift assays (Caliper) assay, IC<sub>50</sub> values can be found in the range of 0.1 nM to 20 nM. For Ba/F3-BCR-ABL-

WT and T315I cellular proliferation assay, GI<sub>50</sub> values can be found in the range of 0.5 nM to 50 nM and 10 nM to 2000 nM, respectively.

Example	Table of biochemical data part I	
	Radio ABL1 (64-515) IC <sub>50</sub> [ $\mu$ M]	Caliper ABL1 (64-515) IC <sub>50</sub> [ $\mu$ M]
1	<0.003	
2	<0.003	
3	<0.003	
4	0.007	
5	<0.003	0.0027
6	<0.003	
7	<0.003	0.0012
8	0.013	0.0028
9	0.017	0.0018
10	0.003	0.0022
11	<0.003	
12	0.01	
13	0.0033	
14	<0.003	
15	<0.003	
16	<0.003	
17	<0.003	
18	<0.003	
19	<0.003	
20	<0.003	
21	0.013	
22	<0.003	
23	<0.003	
24	<0.003	
25	<0.003	0.0019
26	<0.003	
27	<0.003	
28	<0.003	
29	<0.003	
30	<0.003	
31	0.007	
32	<0.003	
33	0.009	0.0048
34	<0.003	0.0008
35	<0.003	0.0012
36	<0.003	
37	0.003	
38	0.004	0.0014
39	<0.003	0.0006
40	0.0002	0.0022
41	<0.003	0.0008
42	<0.003	0.0008
43	0.005	
44	<0.003	
45	<0.003	0.0011
46	0.003	0.004
47	0.003	0.0012
48	0.0042	0.0008
49	0.005	0.0035
50	0.003	0.0011
51	<0.003	0.0029
52	<0.003	0.0006
53	<0.003	0.0004
54	0.005	0.0009
55	0.003	
56	0.004	
57	0.007	
58	0.004	0.0006
59	0.006	
60	0.004	0.006
61	0.004	0.0005
62	0.004	0.0021
63	0.004	
64	<0.003	
65	<0.003	0.0035
66	<0.003	0.0004
67	<0.003	
68	<0.003	0.0009
69	<0.003	0.0005
70	<0.003	0.0004

301

-continued

Example	Radio ABL1 (64-515) IC <sub>50</sub> [μM]	Caliper ABL1 (64-515) IC <sub>50</sub> [μM]
71	0.002	0.0034
72	<0.003	0.0011
73	0.015	0.014
74	0.006	0.004
75	<0.003	0.0006
76	<0.003	
77	0.003	0.0009
78	<0.003	0.0002
79	0.004	0.001
80	0.005	
81	<0.003	
82	<0.003	0.0006
83	0.011	
84	0.003	0.0011
85	0.026	
86	0.0063	0.0006
87	0.006	0.0007
88	0.004	<0.00013
89	<0.003	0.0003
90	<0.003	0.0007
91	0.005	
92	0.006	0.0007
93	0.006	0.0014
94	<0.003	
95	<0.003	
96	<0.003	0.0028
97	<0.003	
98	0.007	
99	<0.003	
100	<0.003	
101	<0.003	
102	<0.003	0.0023
Table of biochemical data part II		
103	<0.003	
104	0.003	
105	<0.003	0.0006
106	<0.003	
107	<0.003	
108	<0.003	0.0003
109	<0.003	
110	0.005	
111	<0.003	
112	<0.003	
113	<0.003	0.0015
114	0.006	
115	0.016	
116	<0.003	0.0035
117	0.0004	0.0055
118	<0.003	
119	0.004	
120	<0.003	
121	<0.003	0.0011
122	0.005	
123	0.017	
124	<0.003	0.0006
125	<0.003	0.0012
126	0.003	
127	0.004	0.0011
128	<0.003	0.0023
129	0.008	0.0054
130	0.003	0.0012
131	0.0084	0.0013
132	<0.003	0.0015
133	<0.003	0.0014
134	0.01	
135	<0.003	0.002
136	<0.003	
137	0.006	0.0006
138	0.007	0.0008
139	0.005	0.0006
140	0.004	0.0004
141	0.006	
142	0.006	
143	0.004	0.0011
144	0.005	

302

-continued

Example	Radio ABL1 (64-515) IC <sub>50</sub> [μM]	Caliper ABL1 (64-515) IC <sub>50</sub> [μM]
145	0.004	
146	<0.003	
147	<0.003	
148	0.003	0.0025
149	0.003	0.0026
150	0.004	0.0065
151	<0.003	<0.00013
152	0.0054	
153	<0.003	
154	<0.003	0.001
155	0.011	0.005
156	0.005	0.0017
157	<0.003	0.002
158	0.037	0.0028
159	<0.003	
160	<0.003	
161	0.012	
162	0.012	
163	<0.003	
164	0.012	
165	<0.003	
166	0.042	
167	0.03	
168	<0.003	
169	0.0011	0.0008
170	<0.003	<0.00013
171	0.004	<0.00013
172	<0.003	0.0003
173	0.003	<0.00013
174	0.003	0.0009
175	0.0005	0.0002
176	0.011	0.0006
177	0.001	0.0003
178	0.013	0.0004
179	0.002	0.0008
180	0.001	0.0004
181	0.004	0.0002
182	0.004	0.0006
183	0.002	0.0005
184	0.006	0.0008
185	0.0024	0.0002
186	0.005	0.0002
187	0.004	0.0002
188	0.004	0.0002
189	0.003	0.001
190	0.0059	0.0005
191	0.008	0.0009
192	0.002	0.0013
193	0.0023	0.0004
194	0.005	0.0014
195	0.003	<0.00013
196	0.0051	0.0007
197	0.016	0.0018
198	<0.003	0.0004
199	0.003	0.0012
200	0.004	0.0012
201	0.004	0.0019
202	0.0034	0.0007
203	0.001	0.0009
204	<0.003	0.0043
Table of biochemical data part III		
205	<0.003	<0.00013
206	0.006	0.0005
207	0.003	0.0011
208	<0.003	0.0006
209	<0.003	0.0005
210	0.004	0.0008
211	0.011	0.0033
212	0.007	0.011
213	0.007	0.016
214	0.008	0.0081
215	0.0012	0.0079
216	0.003	0.0007
217	0.002	0.0004
218	0.003	0.0006

303

-continued

Example	Radio ABL1 (64-515) IC <sub>50</sub> [μM]	Caliper ABL1 (64-515) IC <sub>50</sub> [μM]
219	0.016	0.016
220	0.006	0.0023
221	0.01	0.0013
222	0.011	0.015
223	0.0002	0.01
224	0.0016	0.0047
225	0.002	0.0085
226		0.0019
227	0.0009	0.0016
228	0.001	0.0011
229	0.001	0.0024
230	0.0039	0.0061
231	0.001	0.0059
232	0.006	0.0053
233	0.0024	0.004
234	0.019	
235	0.002	0.0018
236	0.003	0.0014
237	0.0006	0.0012
238	0.002	0.0026
239	0.004	0.0026
240	0.002	0.0014
241	0.0017	0.0013
242	0.006	0.0045
243	0.0013	0.0005
244	0.001	0.0006
245	0.005	0.001
246	0.001	0.0022
247	0.0019	<0.00013
248	0.001	<0.00013
249	0.001	0.0007
250	0.001	0.0013
251	<0.0001	0.0007
252	0.0083	0.0005
253	0.002	0.0005
254	<0.0001	0.0006
255	0.0021	0.0011
256	0.002	0.0004
257	0.003	0.0006
258	0.0027	0.0011
259	0.0051	<0.00013
260	0.0051	0.001
261	0.0018	0.0039
262	0.002	0.0007
263	0.003	<0.00013
264	0.001	0.0006
265	0.003	<0.00013
266	0.007	0.0024
267	0.0013	0.0006
268	0.0005	0.0004
269	<0.0001	<0.00013
270	0.002	0.0006
271	0.0005	0.0007
272	0.004	0.0011
273	0.002	0.0012
274	<0.0001	0.0004
275	0.005	0.0028
276	0.003	0.0068
277	0.002	0.0017
278	0.001	0.0005
279	0.003	0.008
280	0.0020	0.0003
281		0.0110
282		0.0009
284	0.0010	0.0008
285	0.0010	0.0006
286	0.0020	0.0017
287		0.0015
288		0.0010
289	0.0030	0.0007
290	0.0020	0.0008
291		0.0002
292		0.0005
293		0.0007
294		0.0030
295		0.0007

304

-continued

Example	Radio ABL1 (64-515) IC <sub>50</sub> [μM]	Caliper ABL1 (64-515) IC <sub>50</sub> [μM]
296		0.0010
297		0.0014
298		0.002
299		0.0003

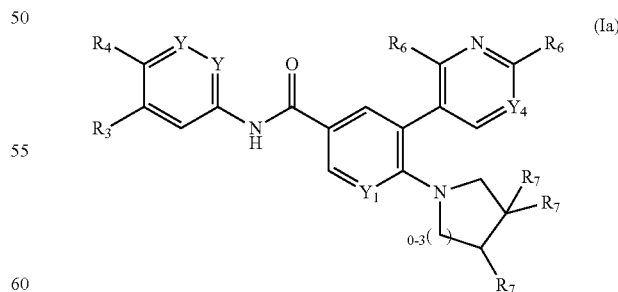
  

Table of Cellular Proliferation Data Ba/F3-BCR-ABL1-WT and T315I		
Example	Ba/F3-BCR-ABL1-WT IC <sub>50</sub> [μM]	Ba/F3-BCR-ABL1-T315I IC <sub>50</sub> [μM]
2	0.0024	0.124
4	0.0056	0.633
35	0.0029	0.088
57	0.0066	1.117
105	0.0125	0.800
129	0.0102	0.513
142	0.0089	0.855
170	0.0005	0.013
171	0.0005	0.012
181	0.0014	0.038
186	0.0007	0.019
187	0.0008	0.024
201	0.0129	0.273
208	0.0039	0.130
212	0.047	0.442
215	0.0246	0.554
216	0.0074	0.169
218	0.0009	0.010
222	0.0435	0.580
248	0.009	0.213
249	0.0049	0.130
257	0.0011	0.038
268	0.0032	0.093
278	0.0009	0.024
283	0.0216	0.370
285	0.0053	0.165
297	0.0013	0.035
298	0.0022	0.036

It is understood that the examples and embodiments described herein are for illustrative purposes only and that various modifications or changes in light thereof will be suggested to persons skilled in the art and are to be included within the spirit and purview of this application and scope of the appended claims.

We claim:

1. A compound of formula (Ia):



in which:

R<sub>4</sub> is selected from the group consisting of —SF<sub>5</sub> and —Y<sub>2</sub>—CF<sub>2</sub>—Y<sub>3</sub>;

R<sub>6</sub> at each occurrence is independently selected from the group consisting of hydrogen, methyl, methoxy, cyano,

## 305

trifluoromethyl, methoxy-carbonyl, 2-hydroxypropan-2-yl, hydroxy-methyl, halo, amino, fluoro-ethyl, ethyl and cyclopropyl;

$R_7$  at each occurrence is independently selected from the group consisting of hydroxy, methyl, methoxy, hydroxy-methyl, amino, methyl-amino, amino-methyl, trifluoromethyl, 2-hydroxypropan-2-yl, methyl-carbonyl-amino, dimethyl-amino, cyano and amino-carbonyl; or two  $R_7$  groups combine with the atom to which they are attached to form a ring selected from the group consisting of cyclopropyl, pyrrolo[3,4-c]pyrazol-5(1H, 4H,6H)-yl and 3-azabicyclo[3.1.0]hexan-3-yl; wherein said 3-azabicyclo[3.1.0]hexan-3-yl can be optionally substituted with amino;

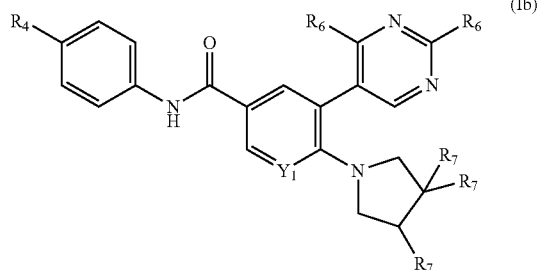
$Y_1$  is selected from the group consisting of N and  $CR_5$ ; wherein  $R_5$  is selected from the group consisting of hydrogen, methoxy and imidazolyl; wherein said imidazolyl is unsubstituted or substituted with methyl;

$Y_2$  is selected from the group consisting of  $CF_2$ , O and  $S(O)_{0-2}$ ; and

$Y_3$  is selected from the group consisting of hydrogen, halo, methyl, difluoromethyl and trifluoromethyl;

$Y_4$  is selected from the group consisting of  $CR_6$  and N; or the pharmaceutically acceptable salts thereof.

2. The compound of claim 1 of formula (Ib):



in which:

$R_4$  is selected from the group consisting of  $-SF_5$  and  $-Y_2-CF_2-Y_3$ ;

$R_6$  at each occurrence is independently selected from the group consisting of hydrogen, methyl, methoxy, cyano, trifluoromethyl, methoxy-carbonyl, 2-hydroxypropan-2-yl, hydroxy-methyl, halo, amino, fluoro-ethyl, ethyl and cyclopropyl;

$R_7$  at each occurrence is independently selected from the group consisting of hydroxy, methyl, methoxy, hydroxy-methyl, amino, methyl-amino, amino-methyl, trifluoromethyl, 2-hydroxypropan-2-yl, methyl-carbonyl-amino, dimethyl-amino, cyano and amino-carbonyl; or two  $R_7$  groups combine with the atom to which they are attached to form a ring selected from the group consisting of cyclopropyl, pyrrolo[3,4-c]pyrazol-5(1H, 4H,6H)-yl and 3-azabicyclo[3.1.0]hexan-3-yl; wherein said 3-azabicyclo[3.1.0]hexan-3-yl can be optionally substituted with amino;

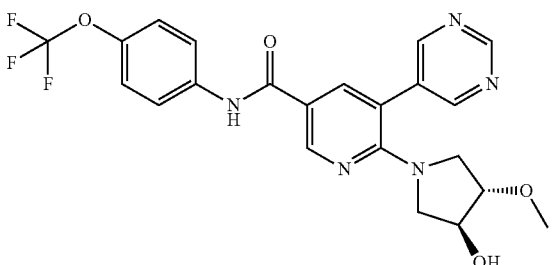
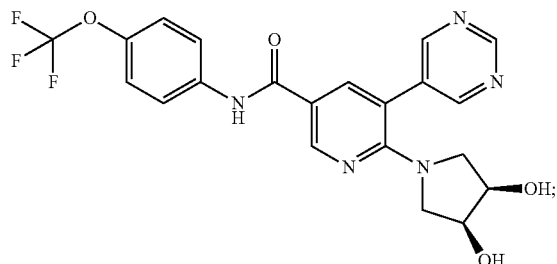
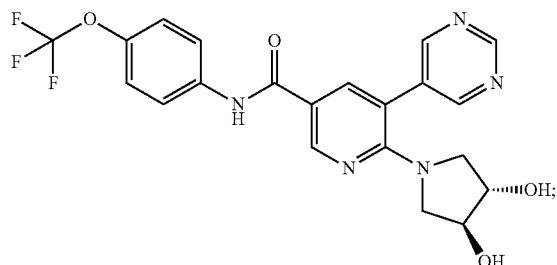
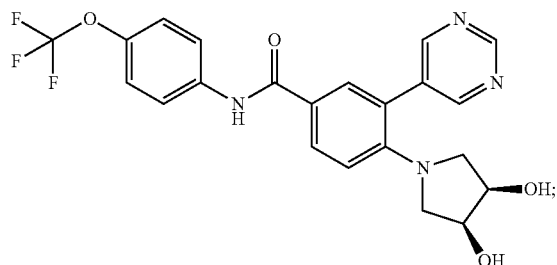
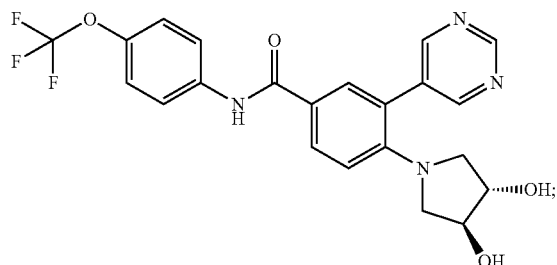
$Y_1$  is selected from the group consisting of CH and N;

$Y_2$  is selected from the group consisting of  $CF_2$ , O and  $S(O)_{0-2}$ ;

## 306

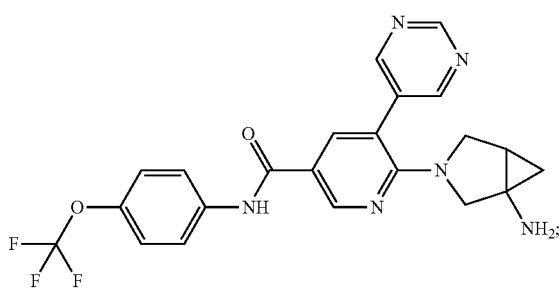
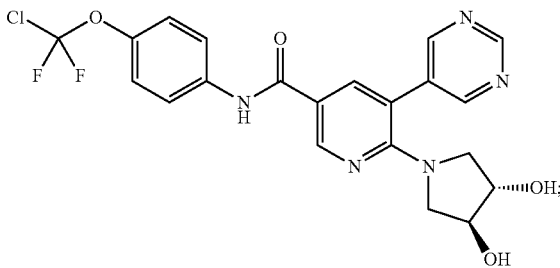
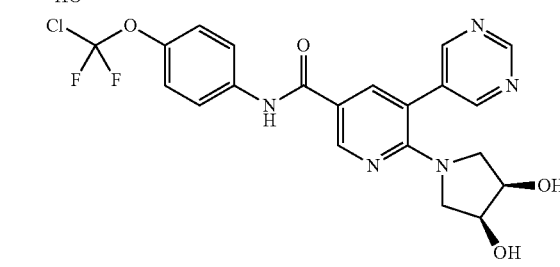
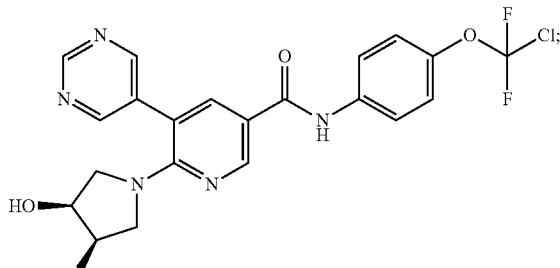
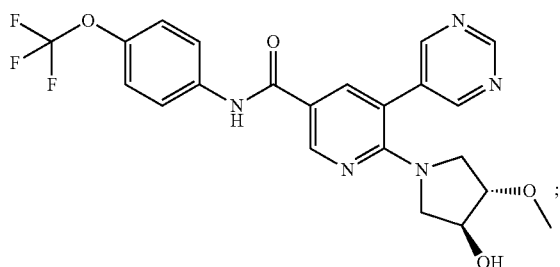
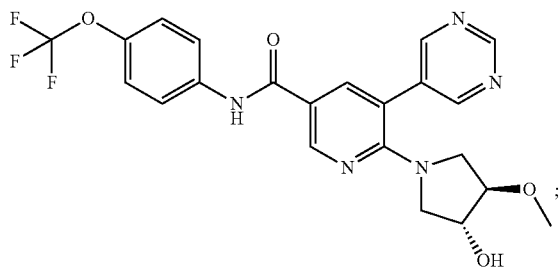
$Y_3$  is selected from the group consisting of hydrogen, fluoro, chloro, methyl, difluoromethyl and trifluoromethyl; or the pharmaceutically acceptable salts thereof.

3. The compound of claim 1, or a pharmaceutically acceptable salt thereof, selected from the group consisting of:



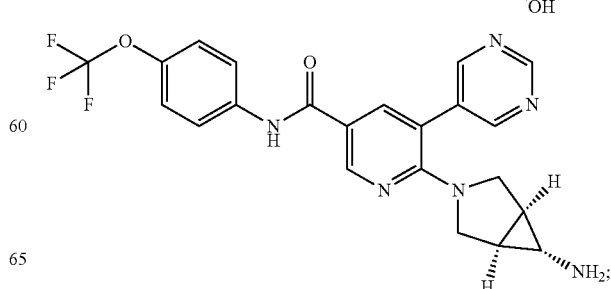
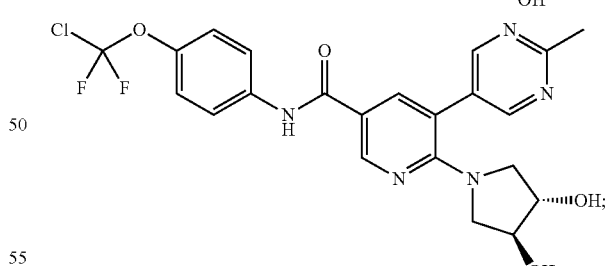
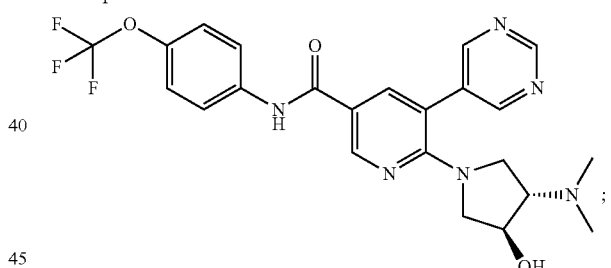
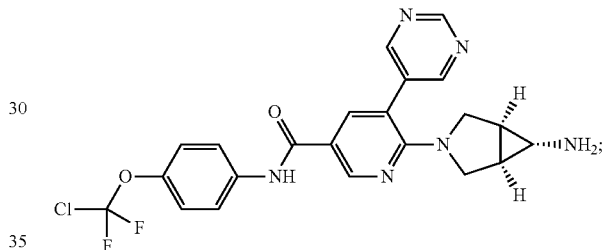
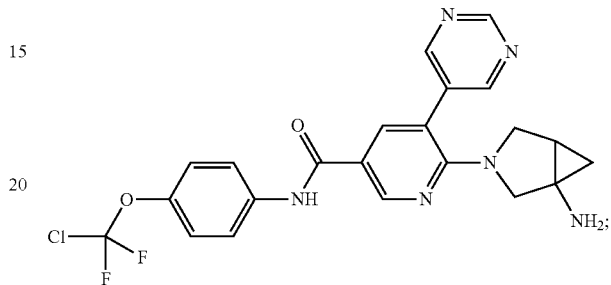
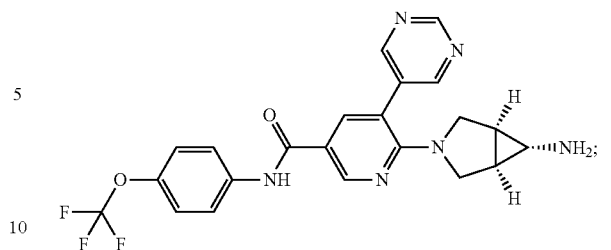
307

-continued



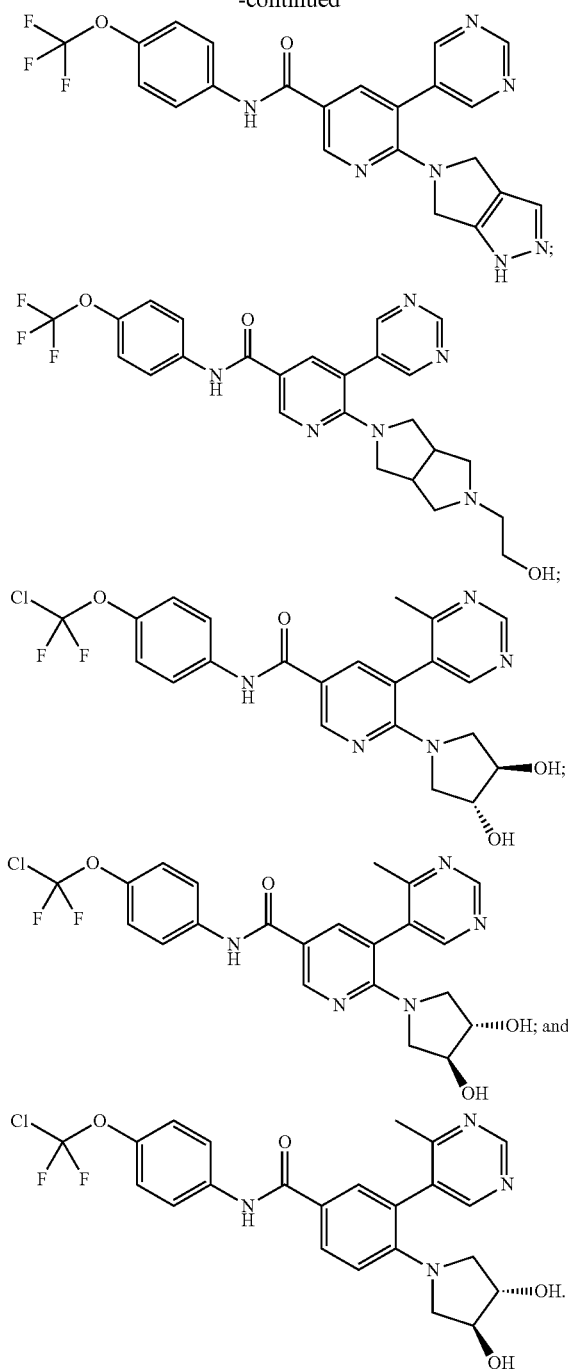
308

-continued

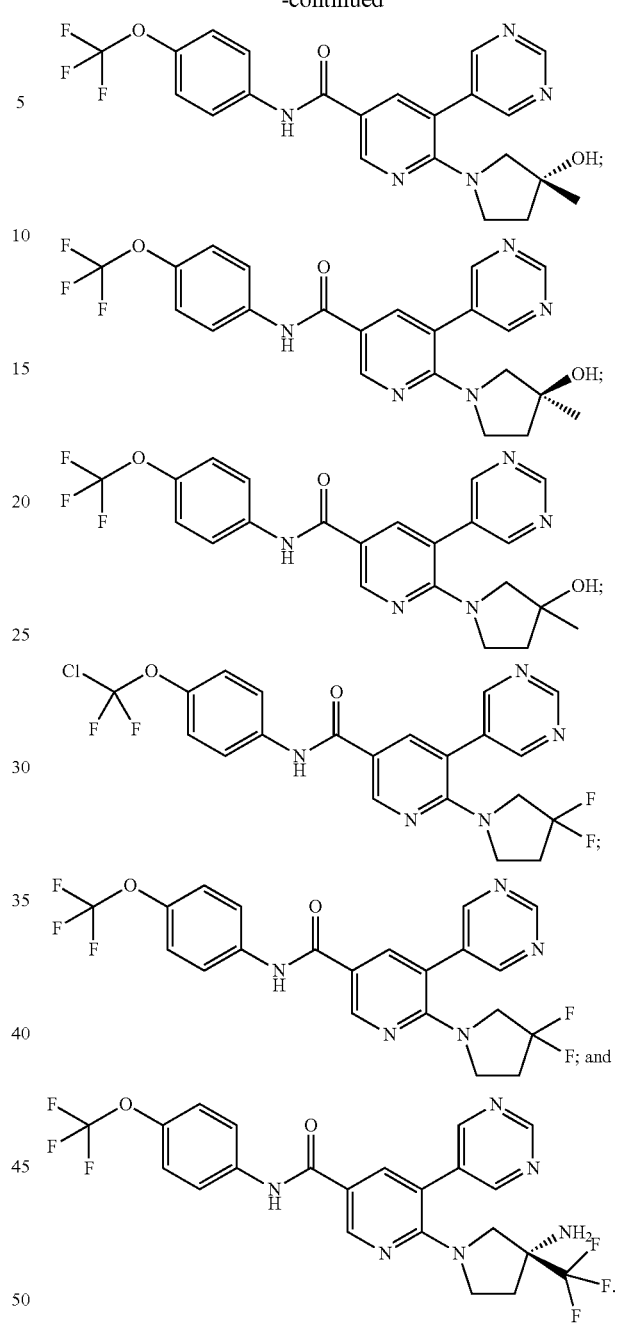


**309**

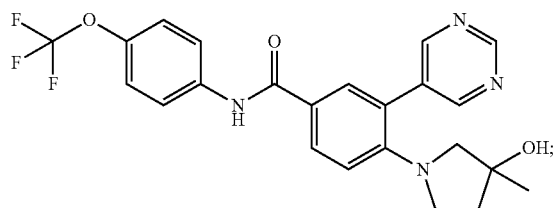
-continued

**310**

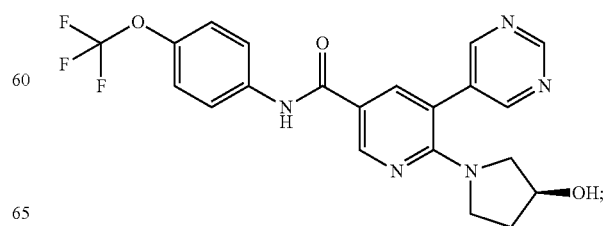
-continued



4. The compound of claim 1, or the pharmaceutically acceptable salt thereof, selected from the group consisting of:

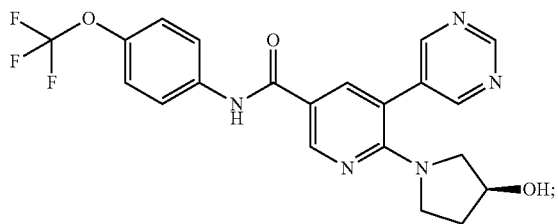
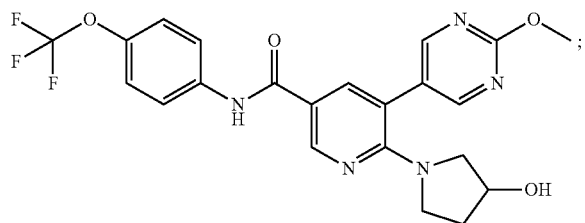
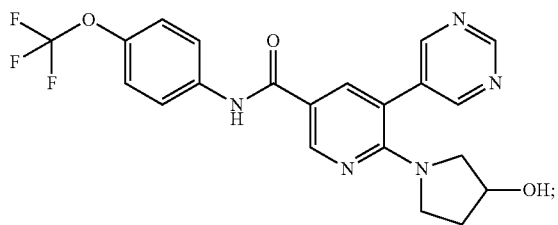
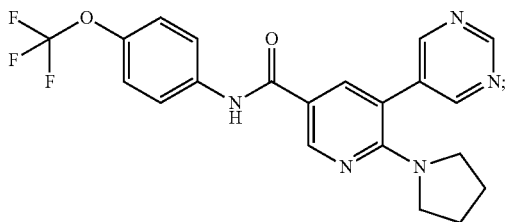
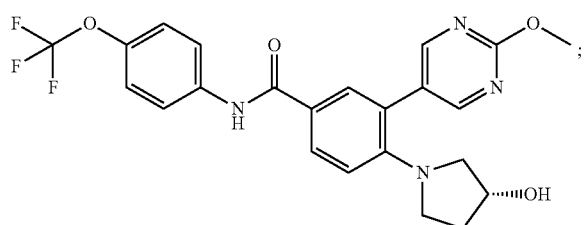
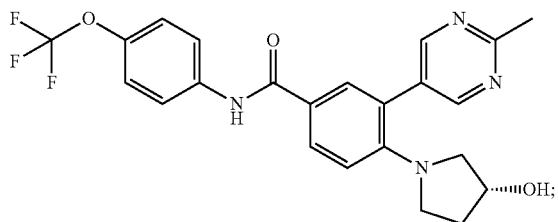
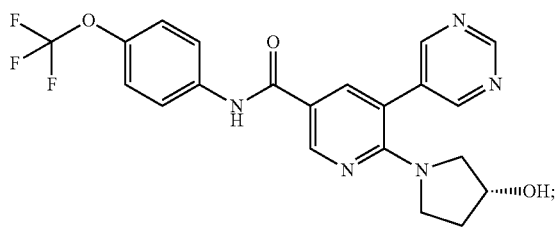


5. The compound of claim 1, or the pharmaceutically acceptable salt thereof, selected from the group consisting of:



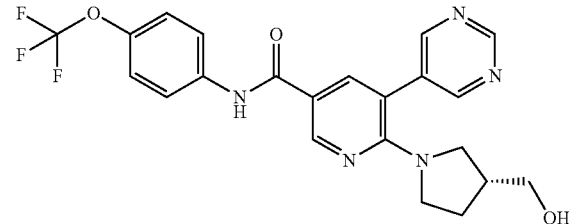
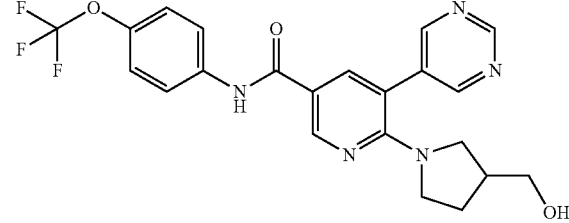
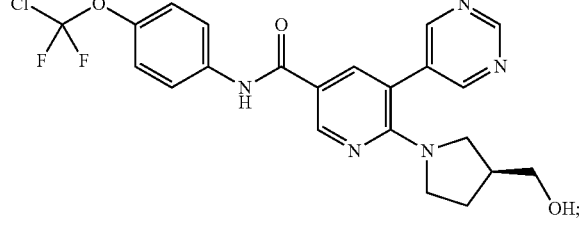
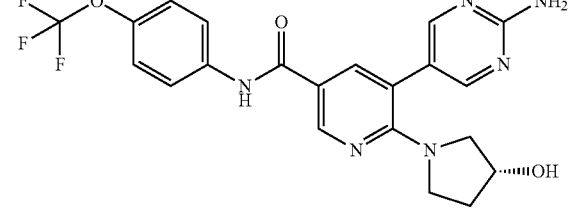
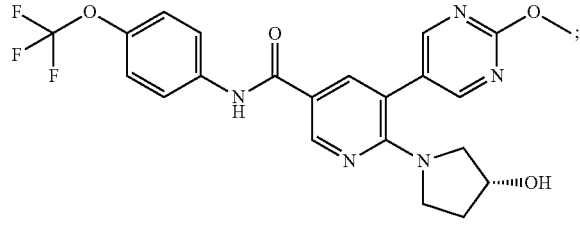
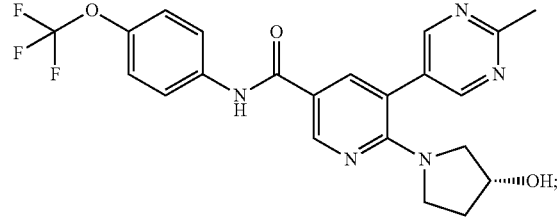
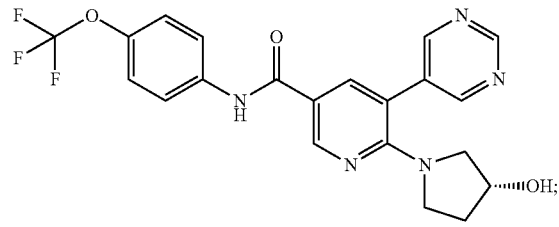
311

-continued



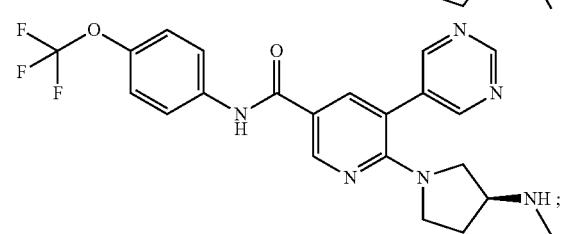
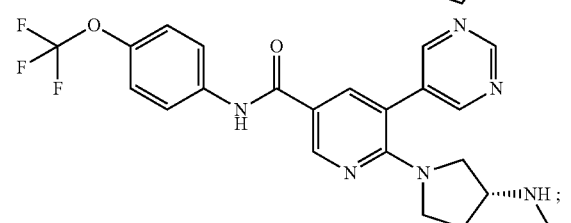
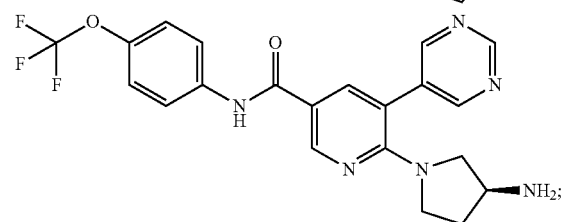
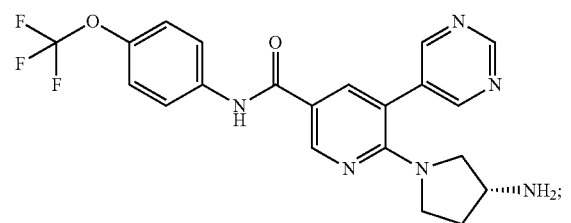
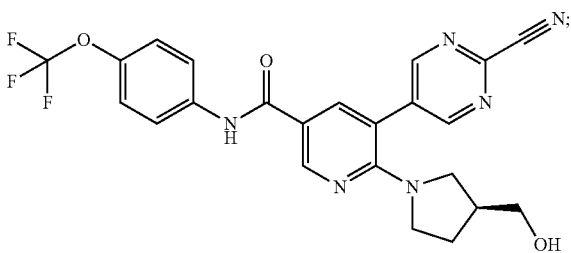
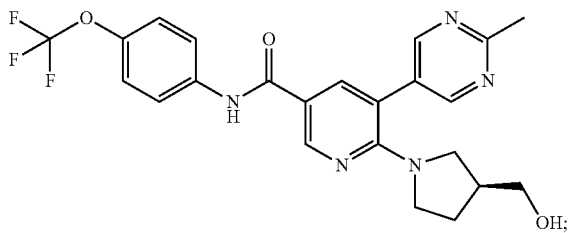
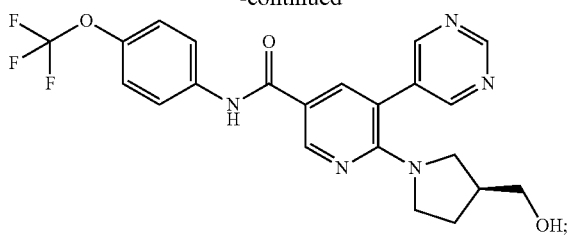
312

-continued

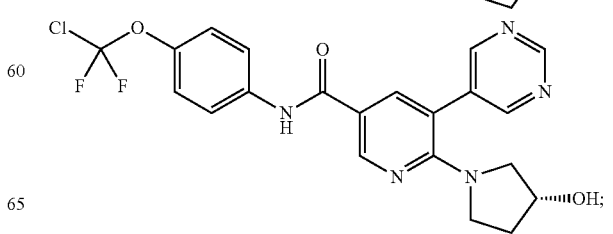
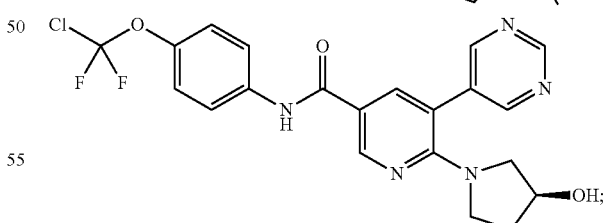
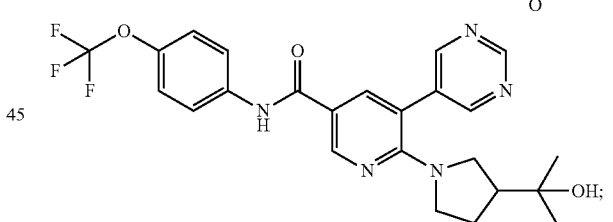
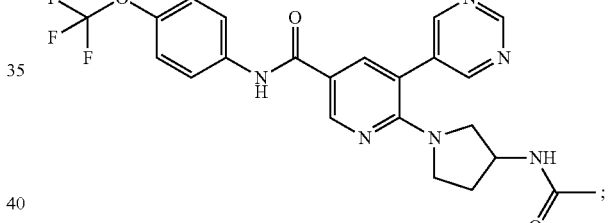
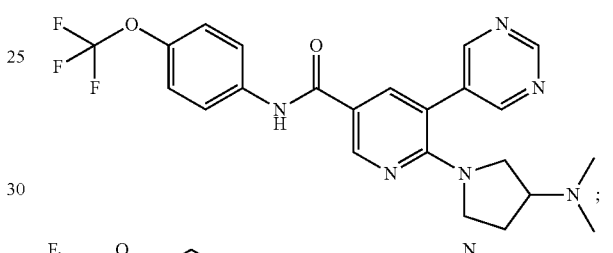
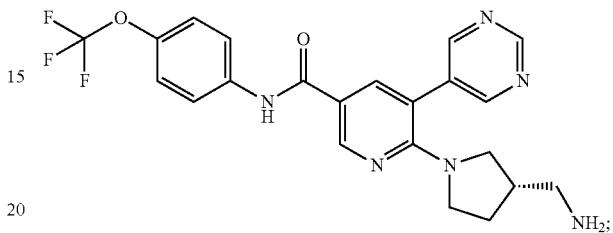
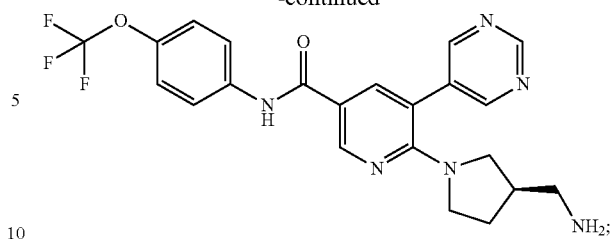


**313**

-continued

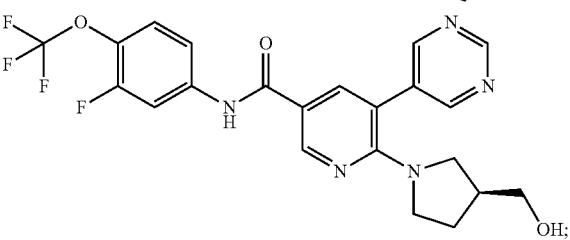
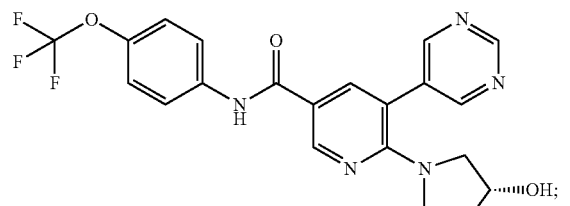
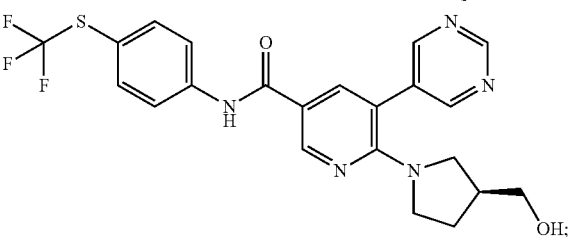
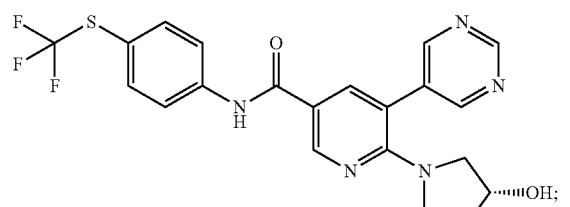
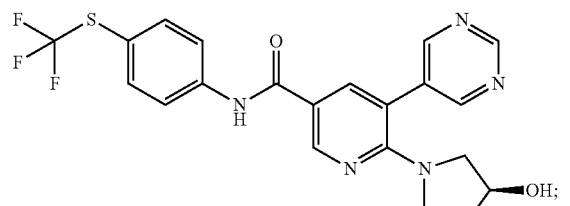
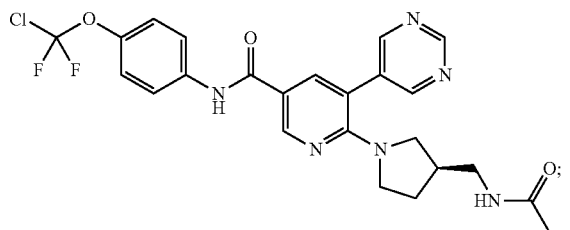
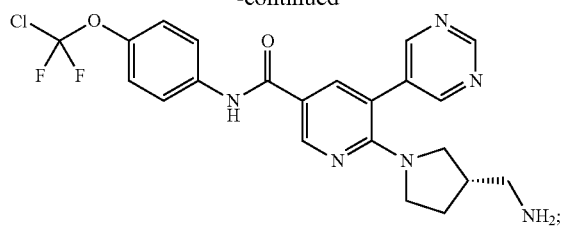
**314**

-continued

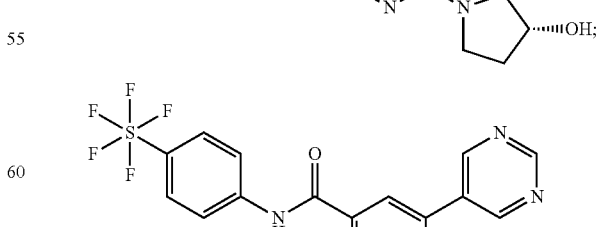
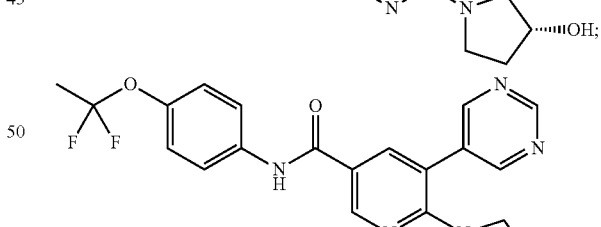
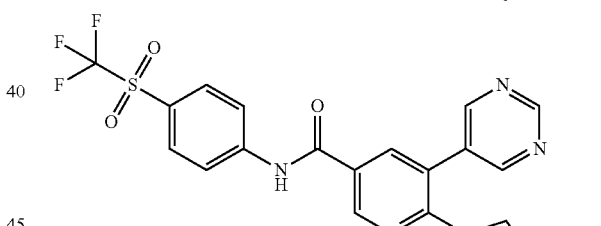
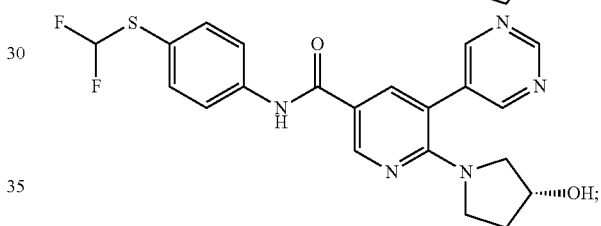
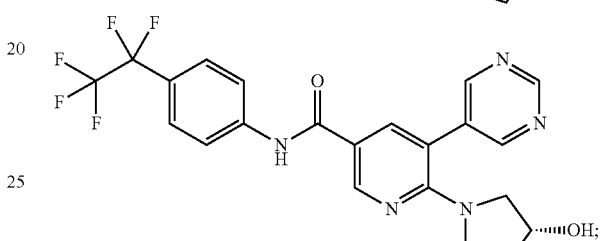
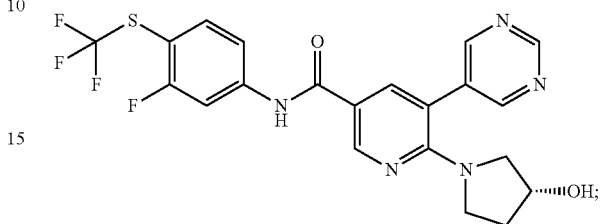
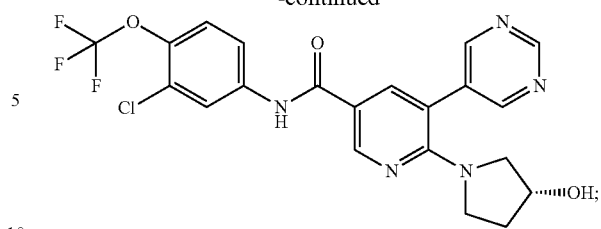


**315**

-continued

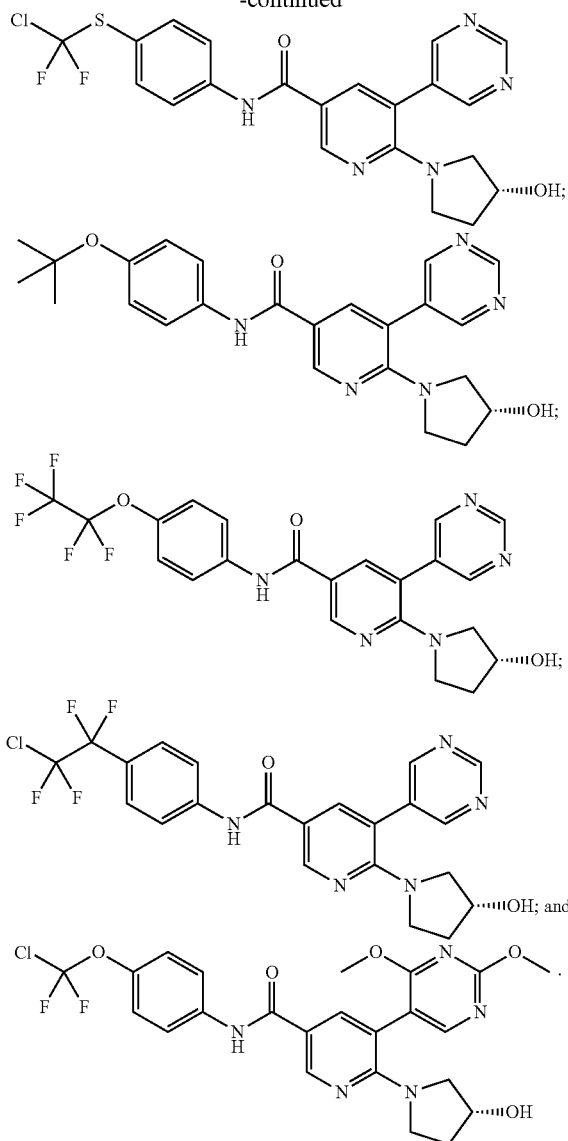
**316**

-continued

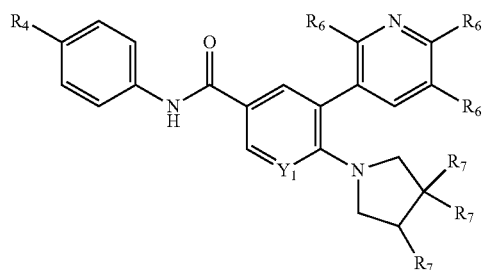


317

-continued



6. The compound of claim 1 of formula (Ic):



in which:

$R_4$  is selected from the group consisting of  $-SF_5$  and  $-Y_2-CF_2-Y_3$ ;

$R_6$  at each occurrence is independently selected from the group consisting of hydrogen, methyl, methoxy, cyano,

318

trifluoromethyl, methoxy-carbonyl, 2-hydroxypropan-2-yl, hydroxy-methyl, halo, amino, fluoro-ethyl, ethyl and cyclopropyl;

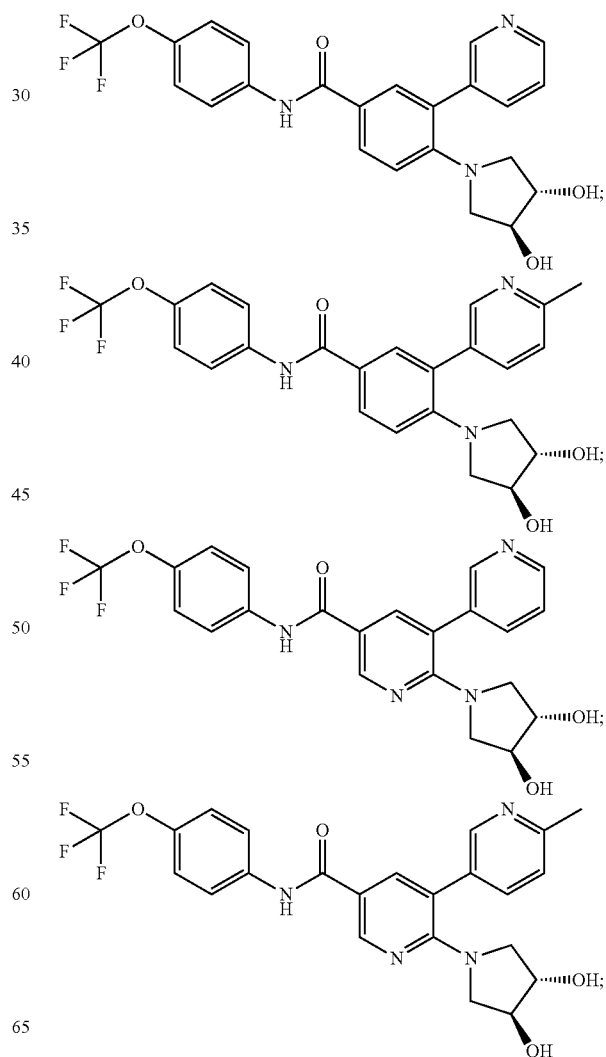
$R_7$  at each occurrence is independently selected from the group consisting of hydroxy, methyl, methoxy, hydroxy-methyl, amino, methyl-amino, amino-methyl, trifluoromethyl, 2-hydroxypropan-2-yl, methyl-carbonyl-amino, dimethyl-amino, cyano and amino-carbonyl; or two  $R_7$  groups combine with the atom to which they are attached to form a ring selected from the group consisting of cyclopropyl and 3-azabicyclo[3.1.0]hexan-3-yl;

$Y_1$  is selected from the group consisting of CH and N;

$Y_2$  is selected from the group consisting of  $CF_2$ , O and  $S(O)_{0-2}$ ;

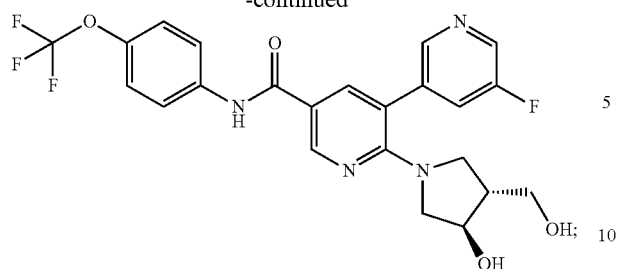
$Y_3$  is selected from the group consisting of hydrogen, fluoro, chloro, methyl, difluoromethyl and trifluoromethyl; or the pharmaceutically acceptable salts thereof.

7. The compound of claim 1, or the pharmaceutically acceptable salt thereof, selected from the group consisting of:



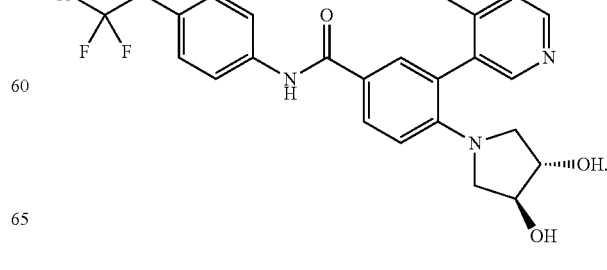
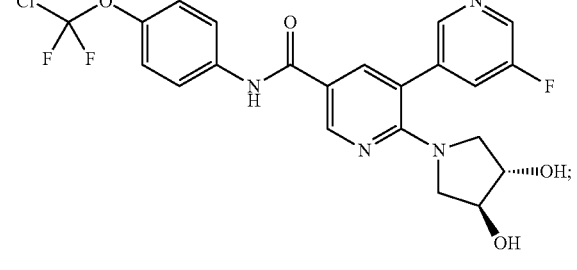
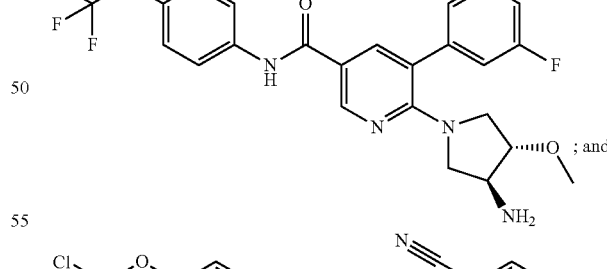
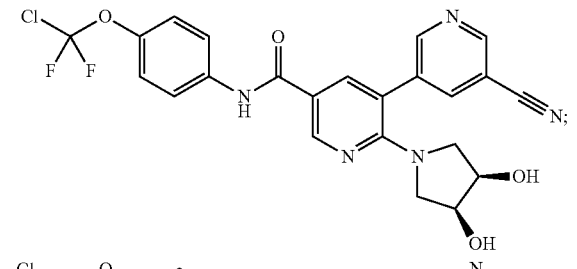
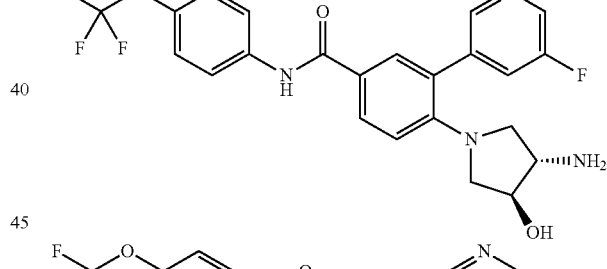
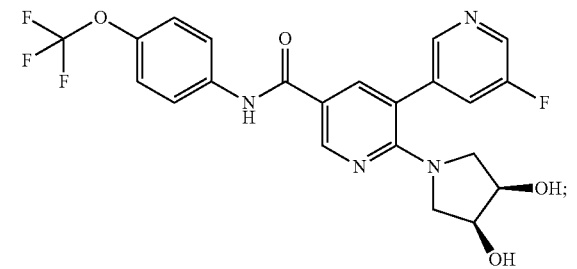
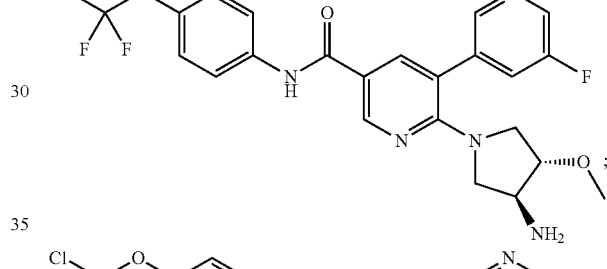
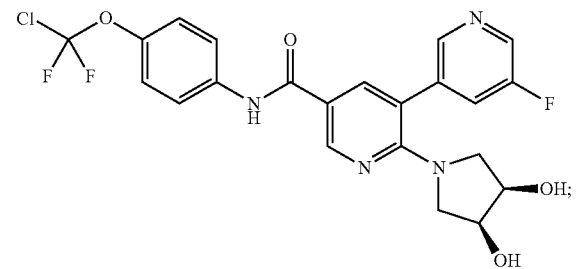
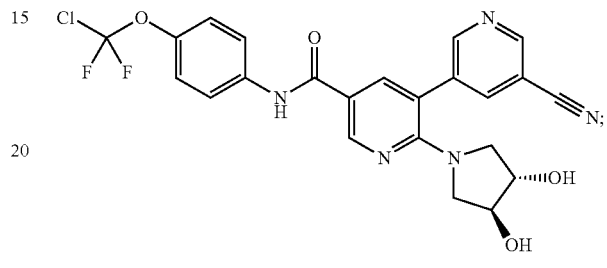
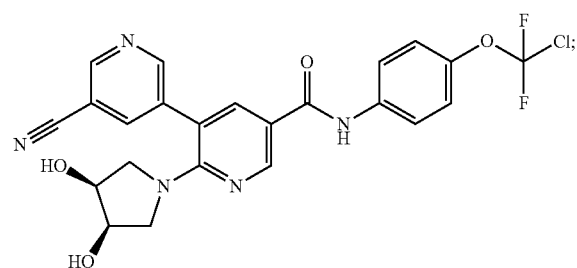
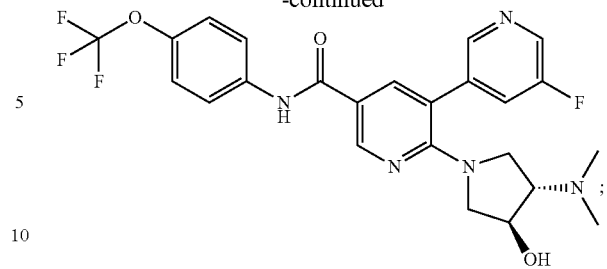
319

-continued



320

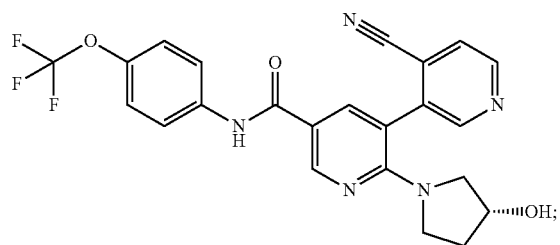
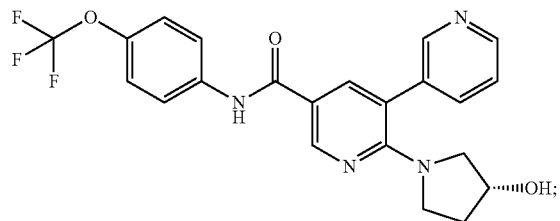
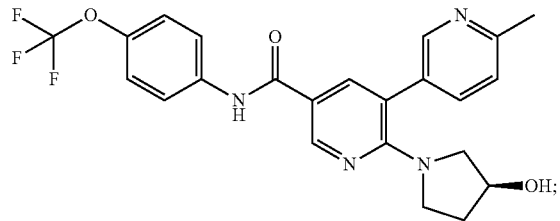
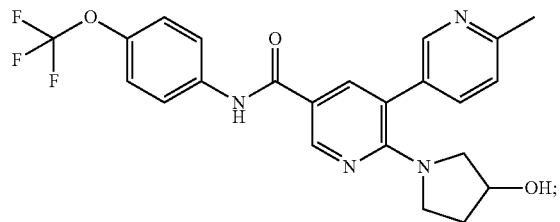
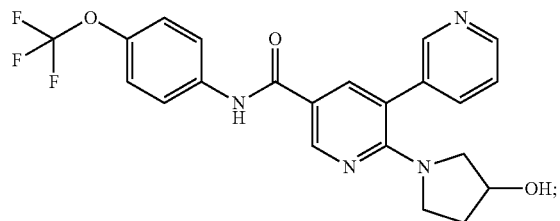
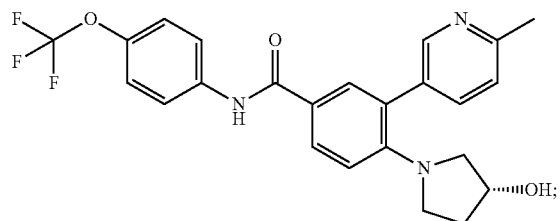
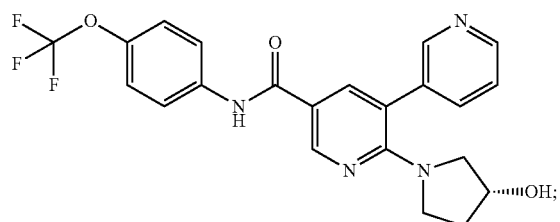
-continued



65

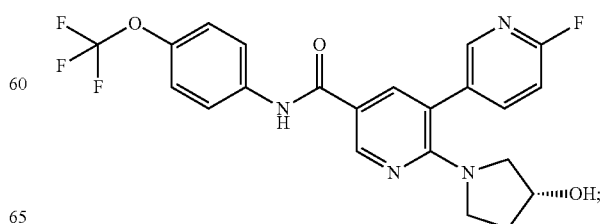
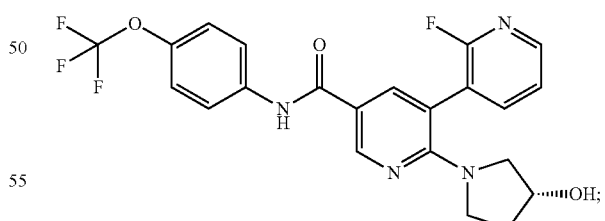
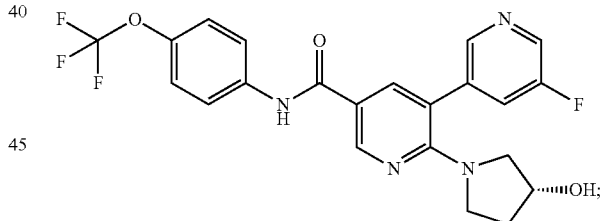
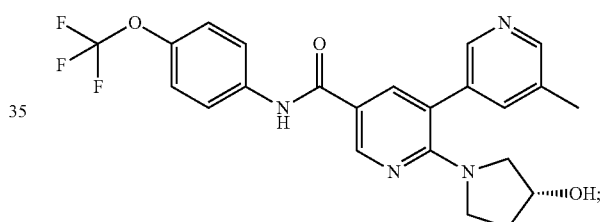
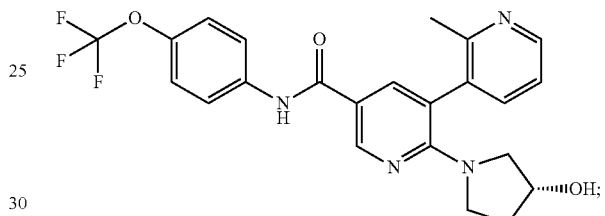
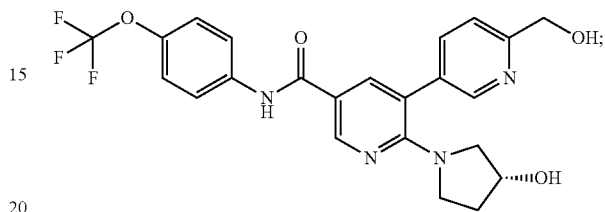
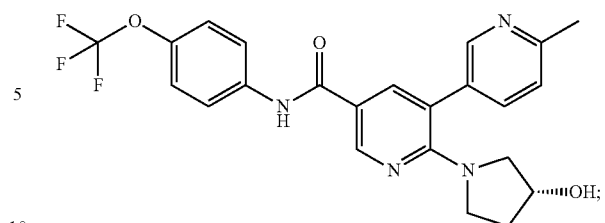
## 321

8. The compound of claim 1, or a pharmaceutically acceptable salt thereof, selected from the group consisting of:



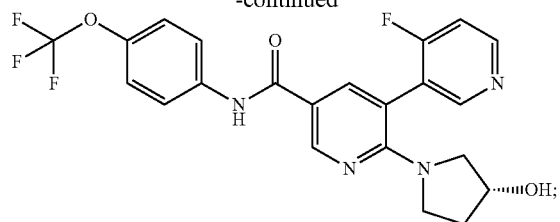
## 322

-continued



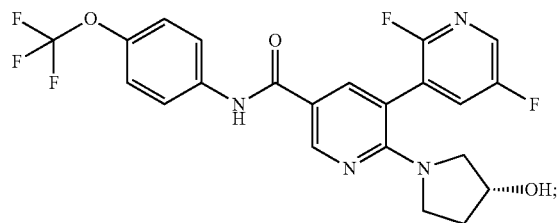
**323**

-continued

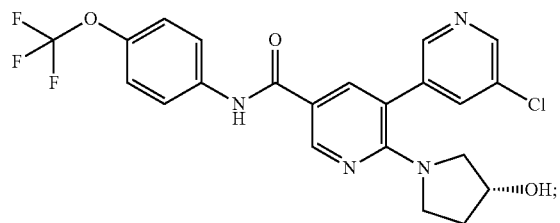


5

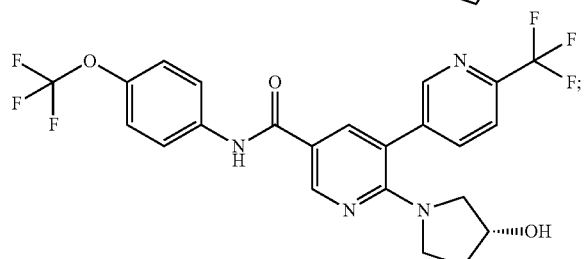
10



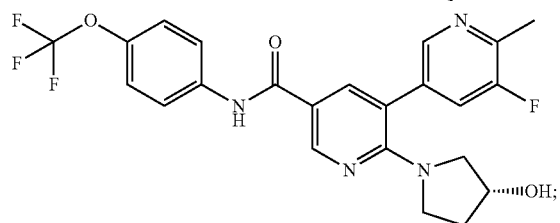
20



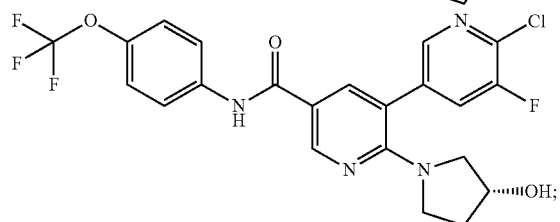
30



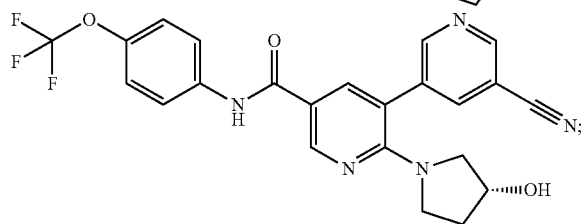
40



45



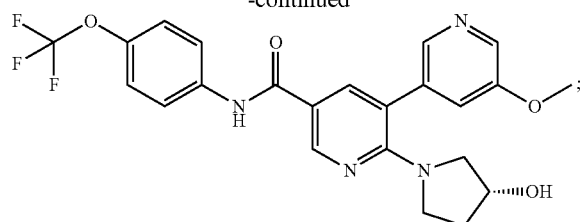
55



65

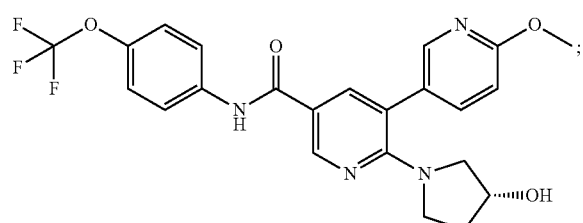
**324**

-continued



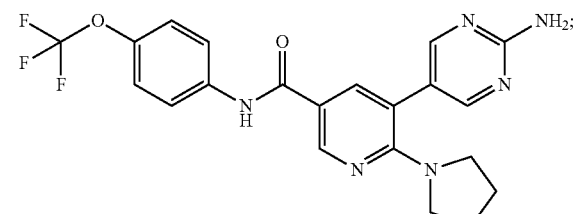
5

10

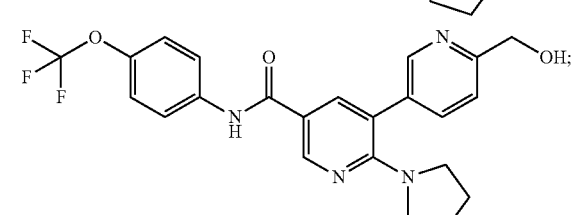


15

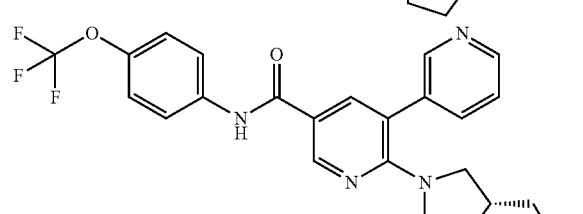
25



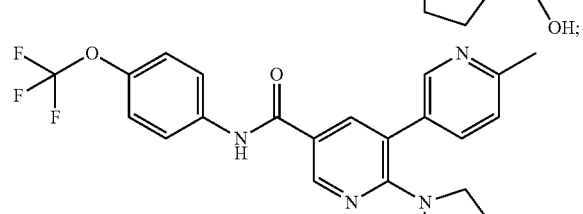
30



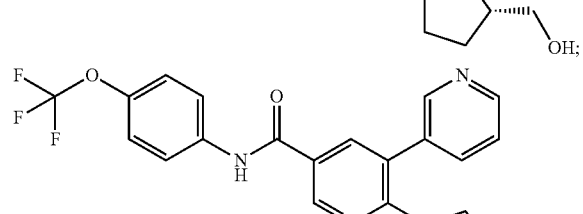
35



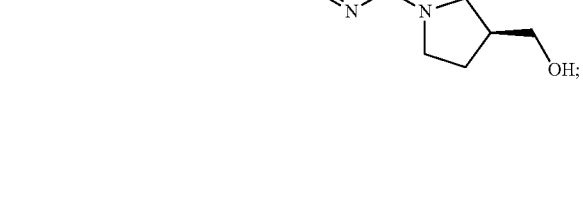
40



45



50



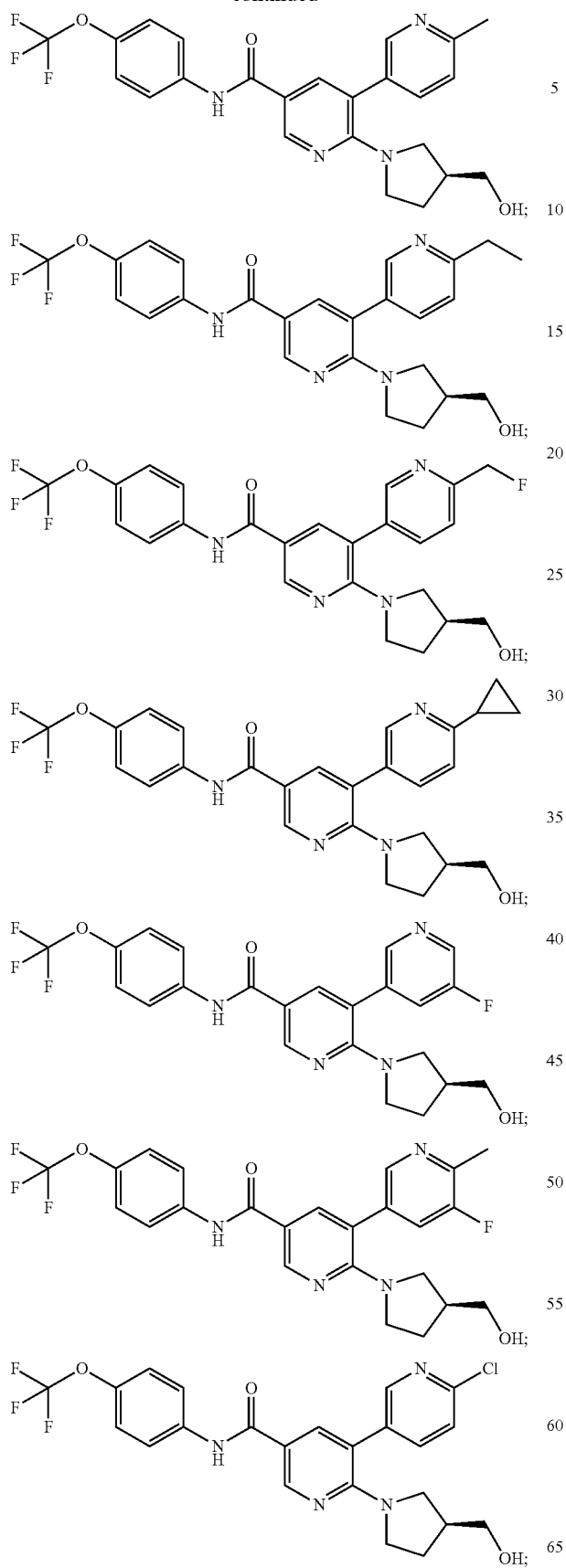
55

60

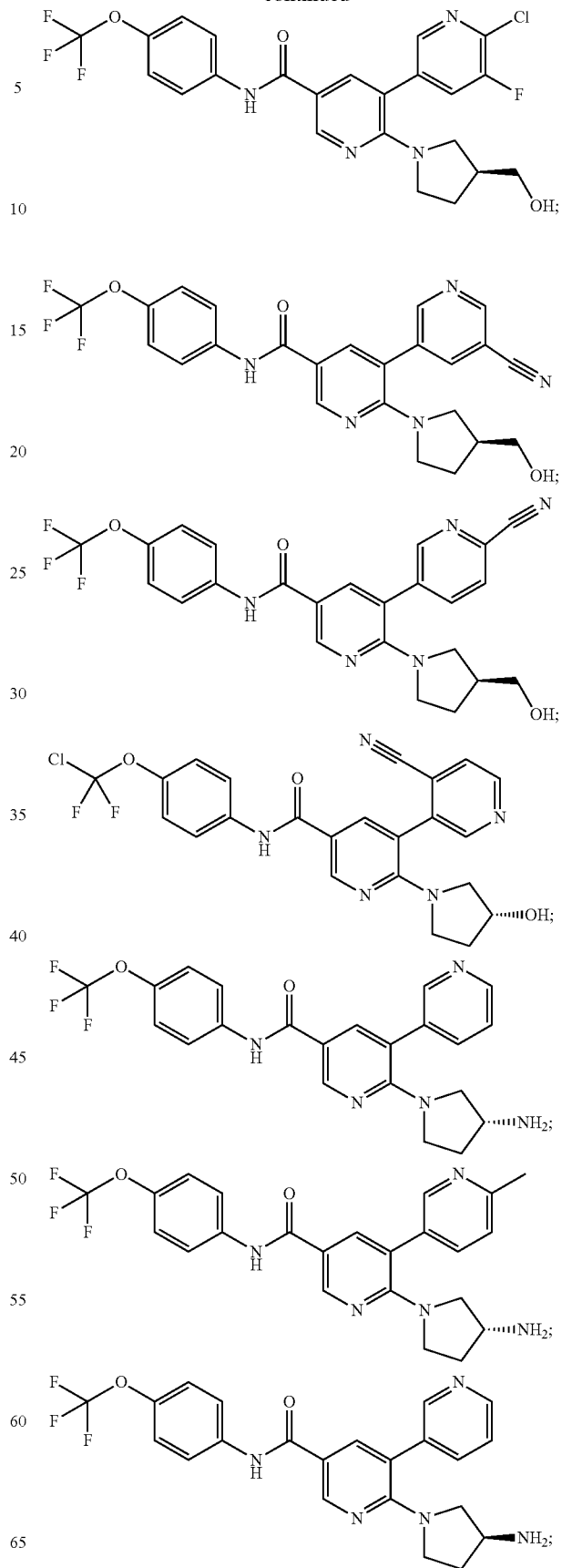
65

**325**

-continued

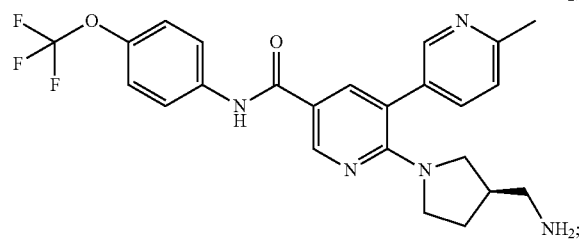
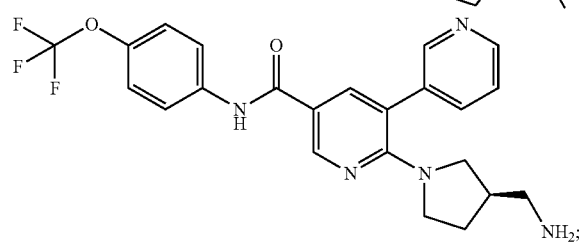
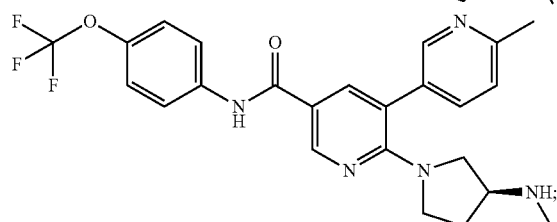
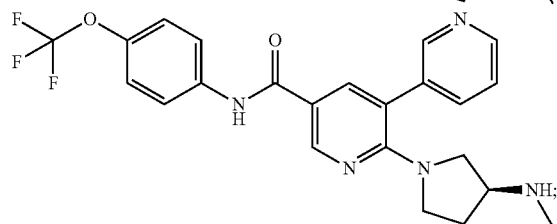
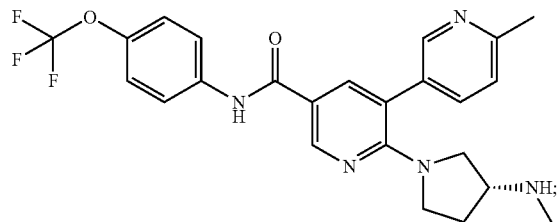
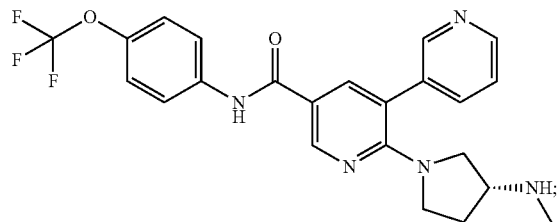
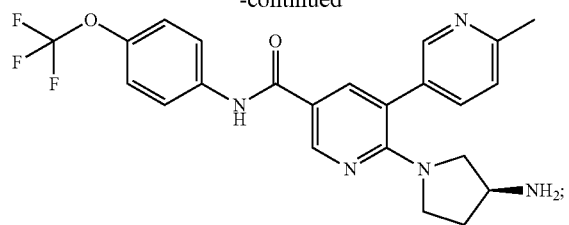
**326**

-continued



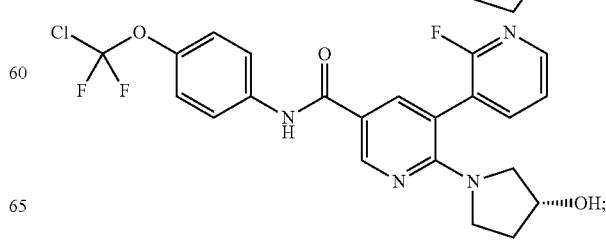
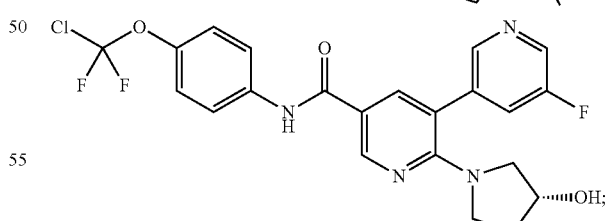
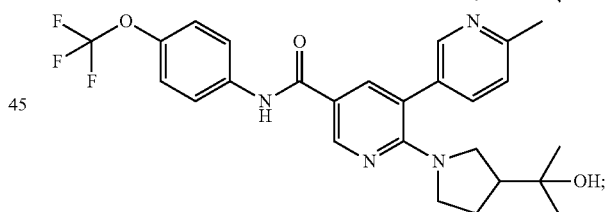
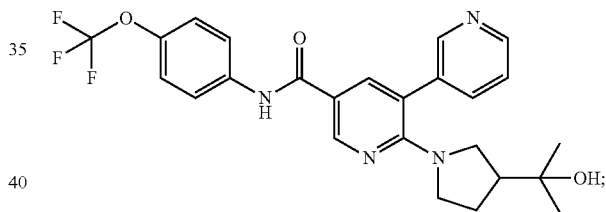
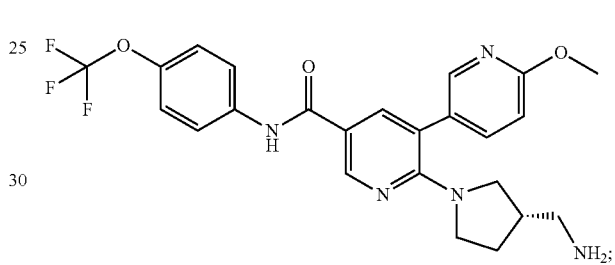
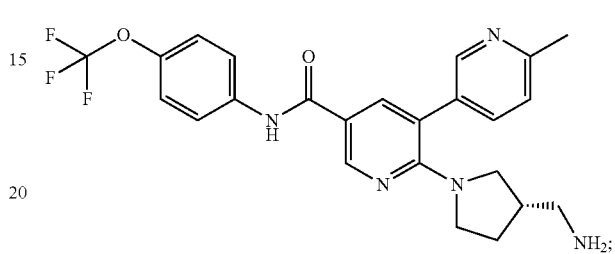
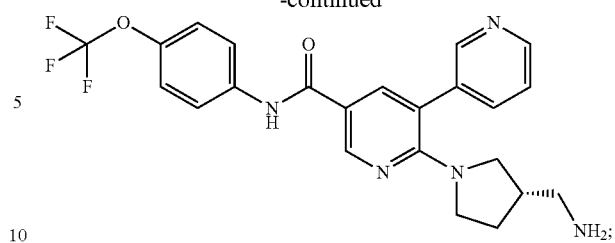
327

-continued



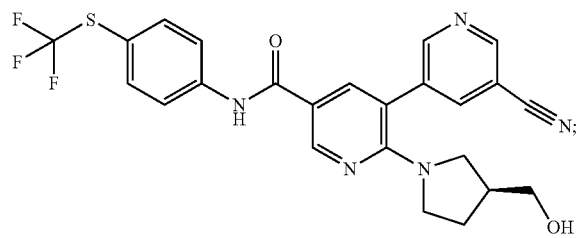
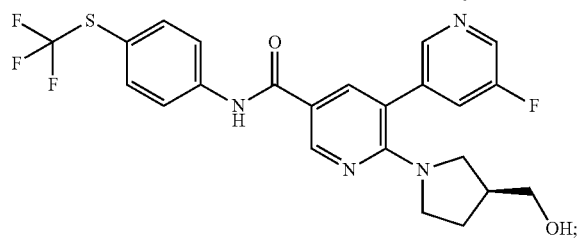
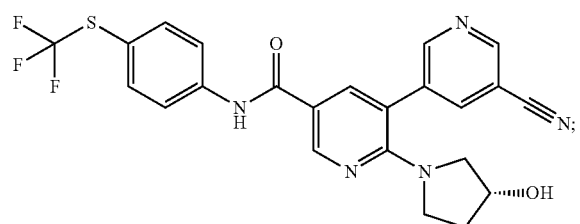
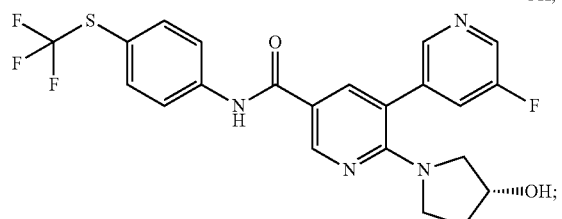
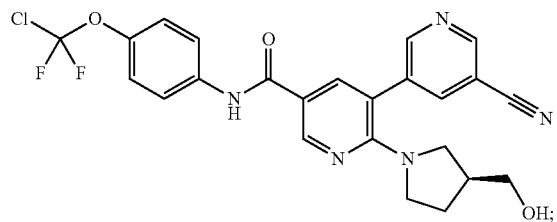
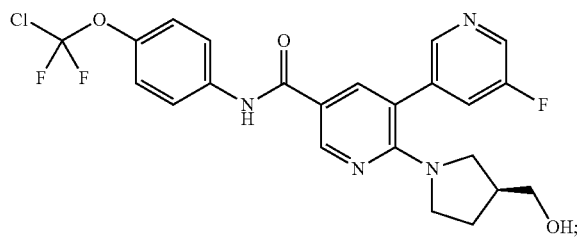
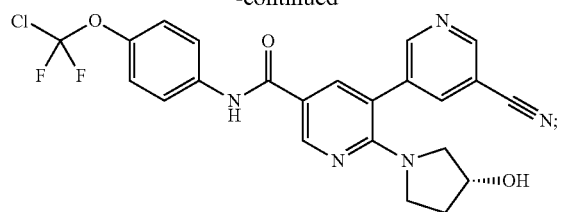
328

-continued

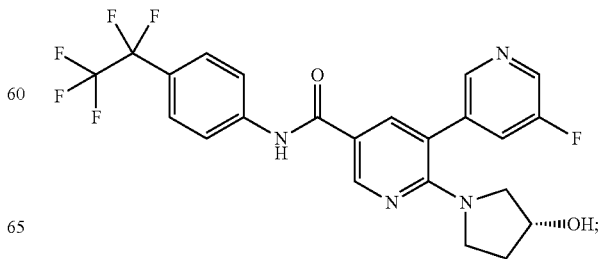
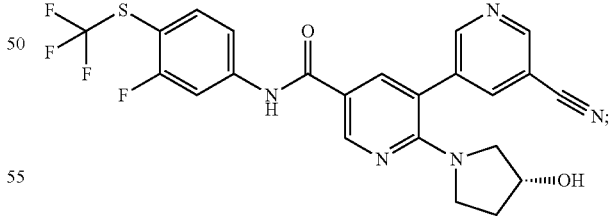
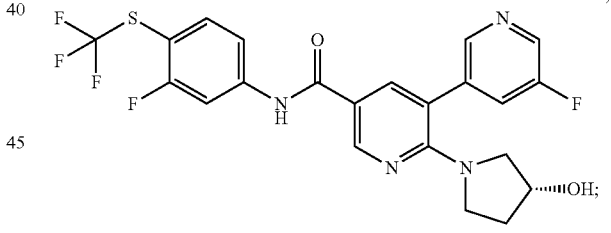
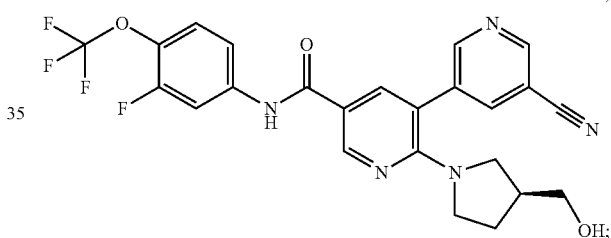
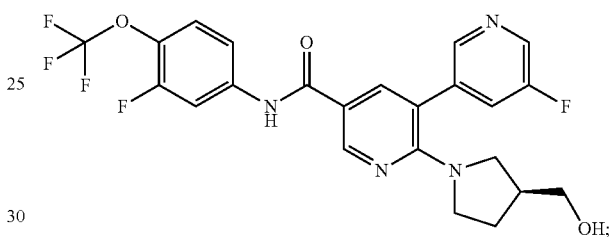
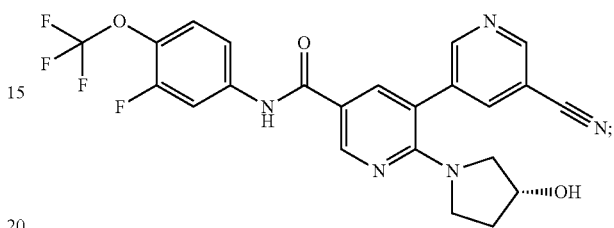
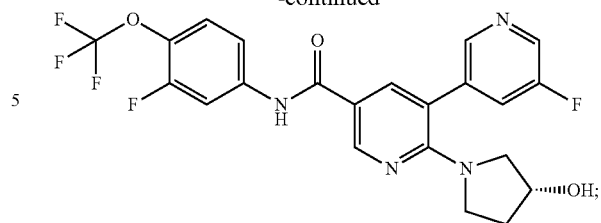


**329**

-continued

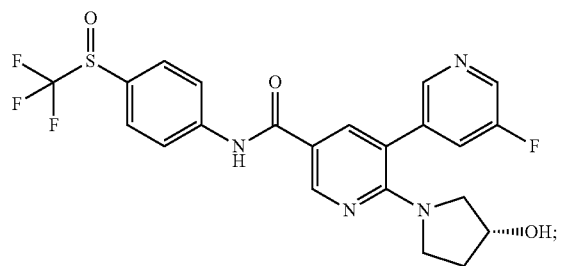
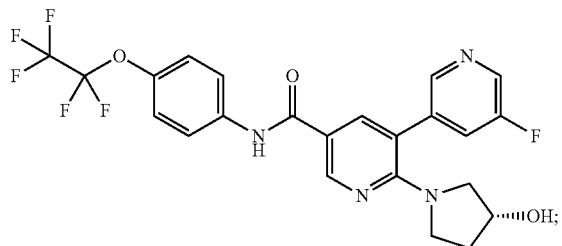
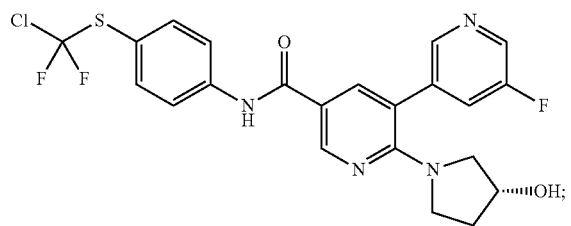
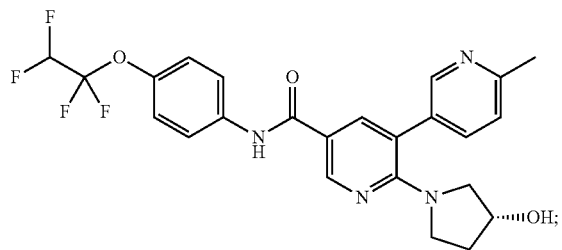
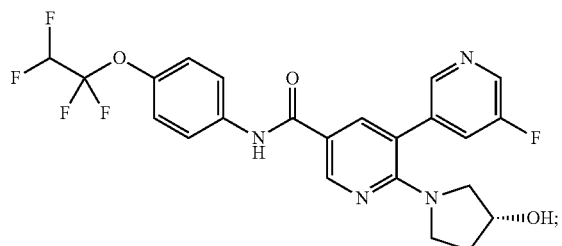
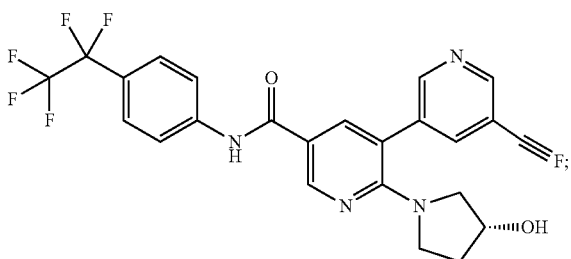
**330**

-continued

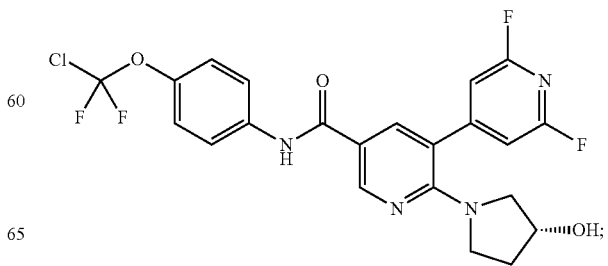
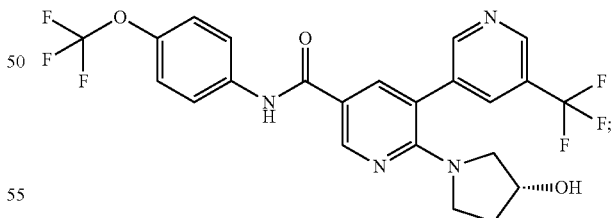
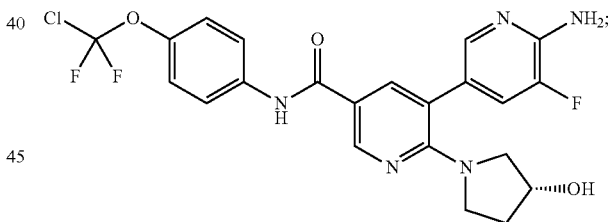
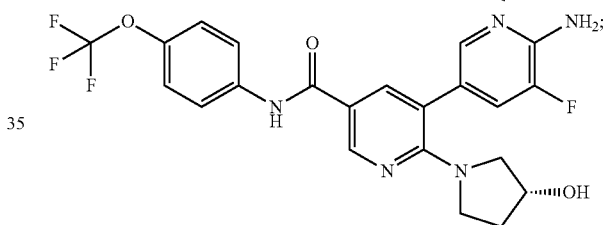
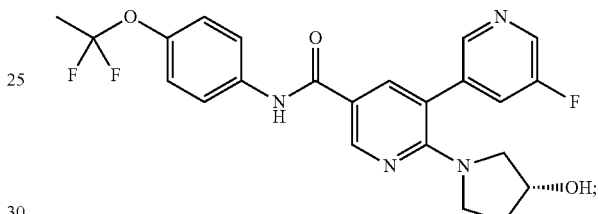
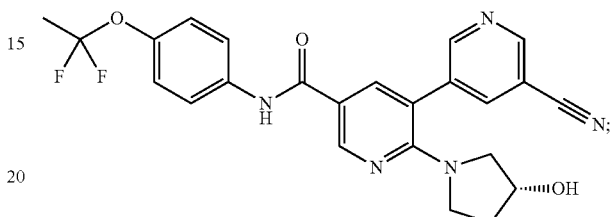
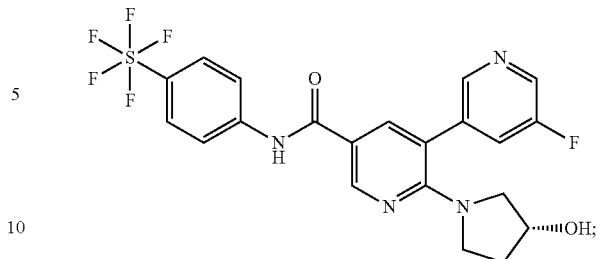


**331**

-continued

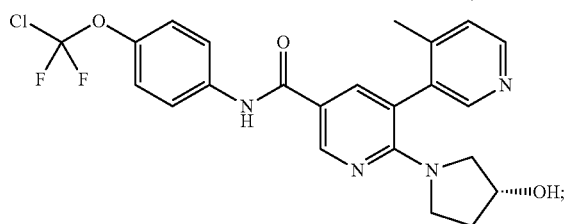
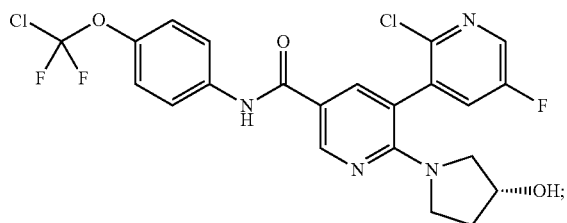
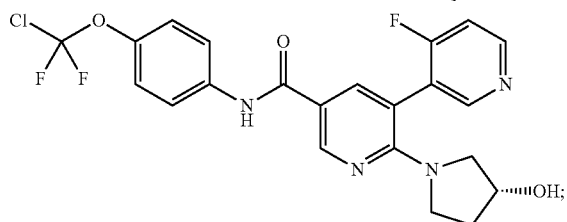
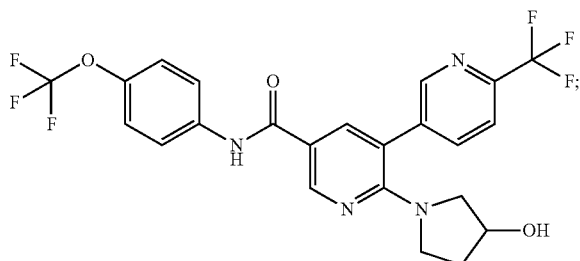
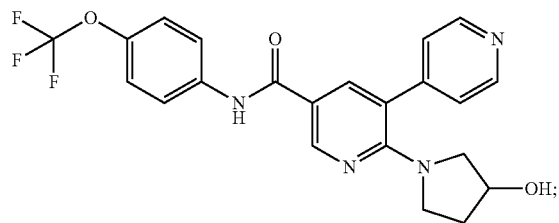
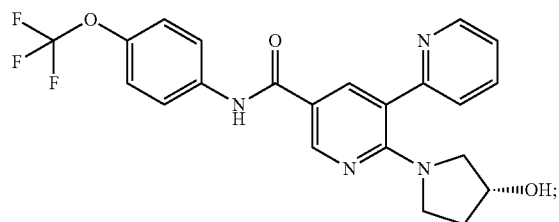
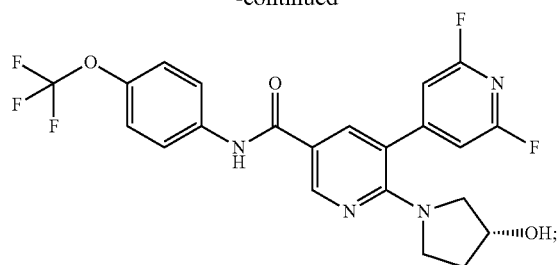
**332**

-continued

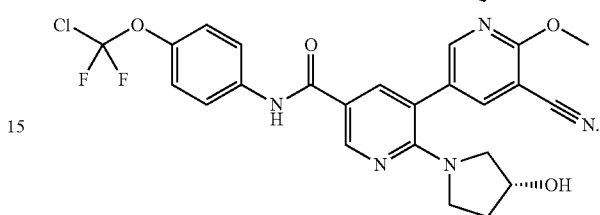
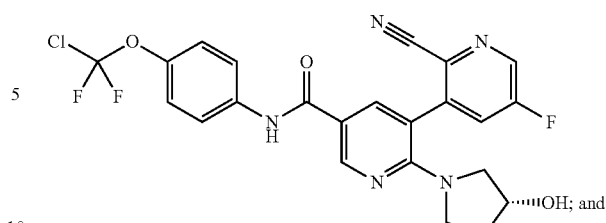


**333**

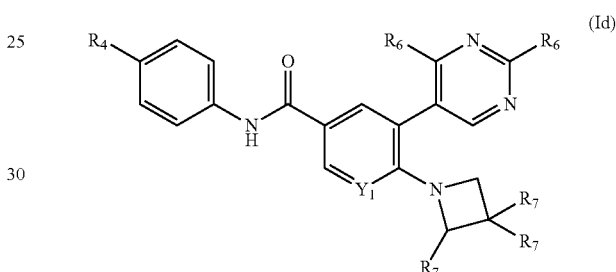
-continued

**334**

-continued



9. The compound of claim 1 of formula (Id):



in which:

$R_4$  is selected from the group consisting of  $-\text{SF}_5$  and  $-\text{Y}_2-\text{CF}_2-\text{Y}_3$ ;

$R_6$  at each occurrence is independently selected from the group consisting of hydrogen, methyl, methoxy, methoxy-carbonyl, 2-hydroxypropan-2-yl, cyano, trifluoromethyl, hydroxy-methyl, halo, amino, fluoro-ethyl, ethyl and cyclopropyl;

$R_7$  at each occurrence is independently selected from the group consisting of hydroxy, methyl, methoxy, hydroxy-methyl, amino, methyl-amino, amino-methyl, trifluoromethyl, 2-hydroxypropan-2-yl, methyl-carbonyl-amino, dimethyl-amino, cyano and amino-carbonyl; or two  $R_7$  groups combine with the atom to which they are attached to form a ring selected from the group consisting of cyclopropyl and 3-azabicyclo[3.1.0]hexan-3-yl;

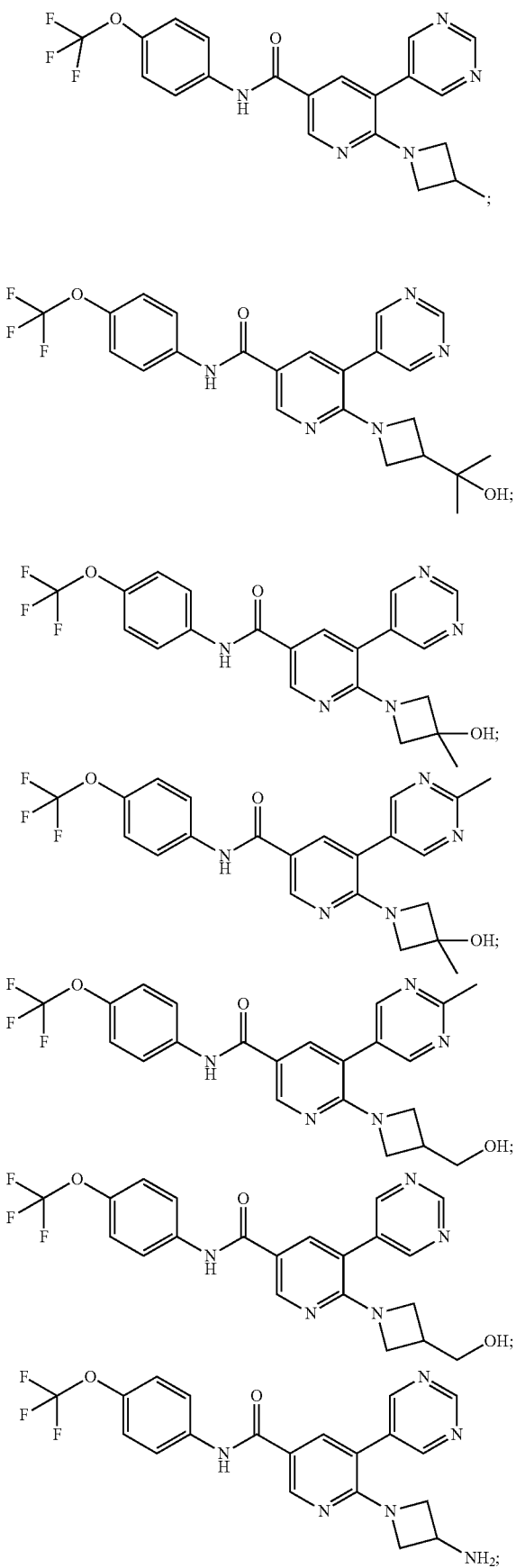
$\text{Y}_1$  is selected from the group consisting of CH and N;

$\text{Y}_2$  is selected from the group consisting of  $\text{CF}_2$ , O and  $\text{S}(\text{O})_{0-2}$ ;

$\text{Y}_3$  is selected from the group consisting of hydrogen, fluoro, chloro, methyl, difluoromethyl and trifluoromethyl; or the pharmaceutically acceptable salts thereof.

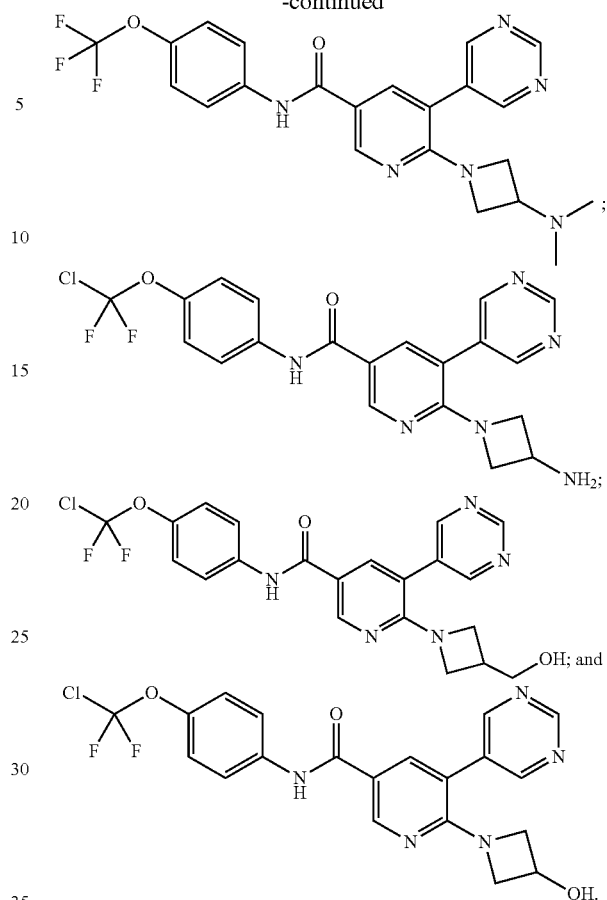
10. The compound of claim 9, or the pharmaceutically acceptable salt thereof, selected from the group consisting of:

335

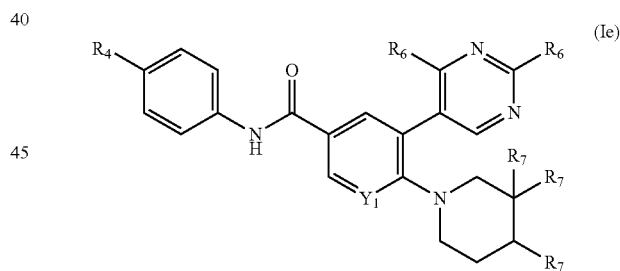


336

-continued



11. The compound of claim 1 of formula (Ie):



in which:

R<sub>4</sub> is selected from the group consisting of —SF<sub>5</sub> and —Y<sub>2</sub>—CF<sub>2</sub>—Y<sub>3</sub>;

R<sub>6</sub> at each occurrence is independently selected from the group consisting of hydrogen, methyl, methoxy, cyano, trifluoromethyl, methoxy-carbonyl, 2-hydroxypropan-2-yl, hydroxy-methyl, halo, amino, fluoro-ethyl, ethyl and cyclopropyl;

R<sub>7</sub> at each occurrence is independently selected from the group consisting of hydroxy, methyl, methoxy, hydroxy-methyl, amino, methyl-amino, amino-methyl, trifluoromethyl, 2-hydroxypropan-2-yl, methyl-carbonyl-amino, dimethyl-amino, cyano and amino-carbonyl; or two R<sub>7</sub> groups combine with the atom to which they

337

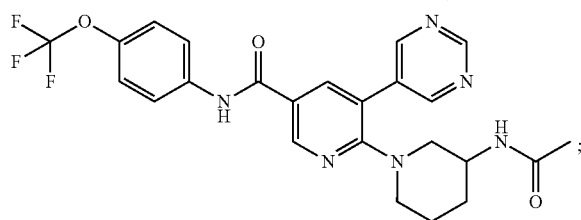
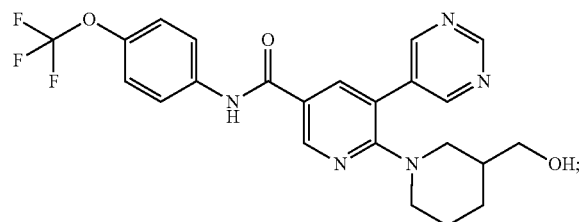
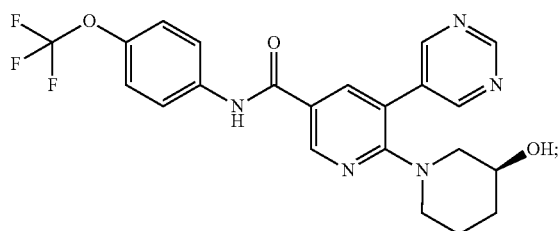
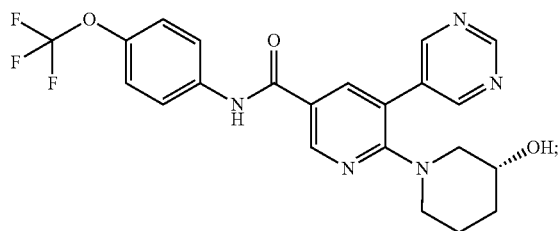
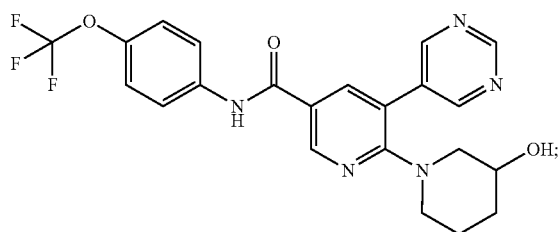
are attached to form a ring selected from the group consisting of cyclopropyl and 3-azabicyclo[3.1.0]hexan-3-yl;

$Y_1$  is selected from the group consisting of CH and N;

$Y_2$  is selected from the group consisting of  $CF_2$ , O and  $S(O)_{0-2}$ ;

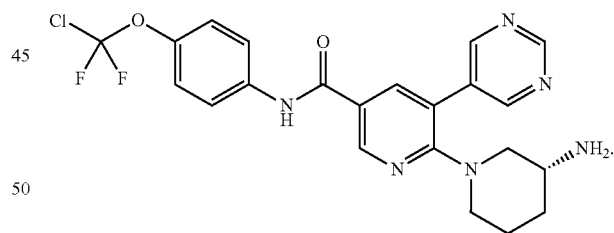
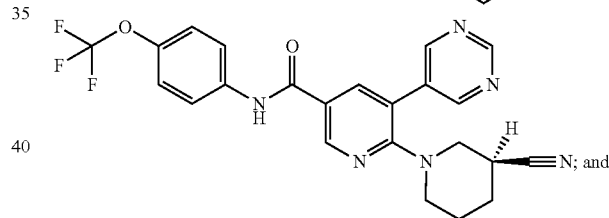
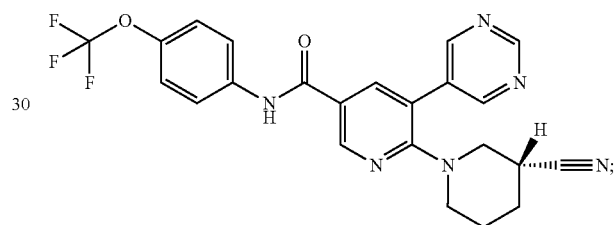
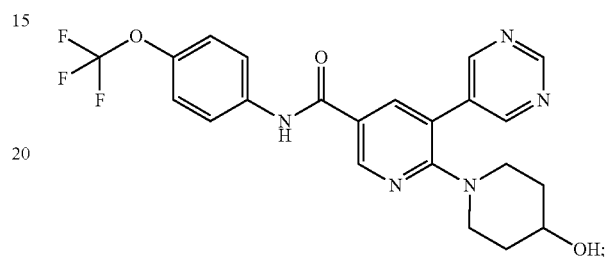
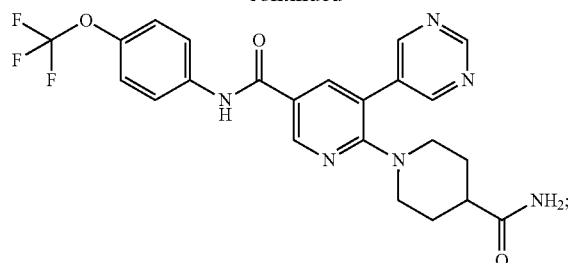
$Y_3$  is selected from the group consisting of hydrogen, fluoro, chloro, methyl, difluoromethyl and trifluoromethyl; or the pharmaceutically acceptable salts thereof.

12. The compound of claim 11, or the pharmaceutically acceptable salts thereof, selected from the group consisting of:

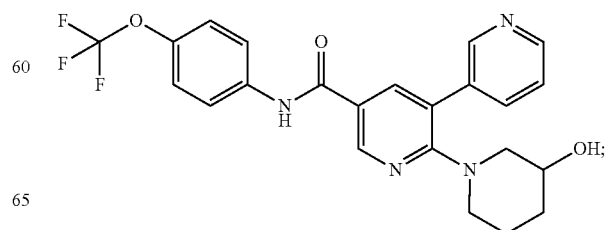


338

-continued

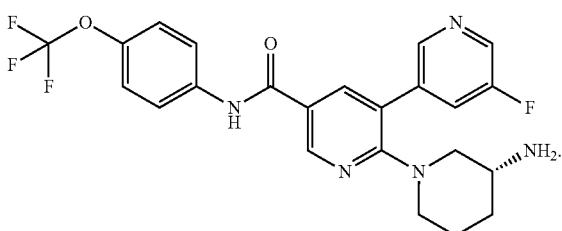
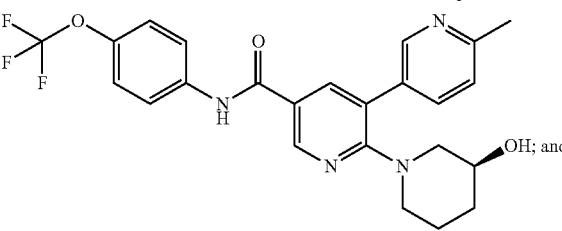
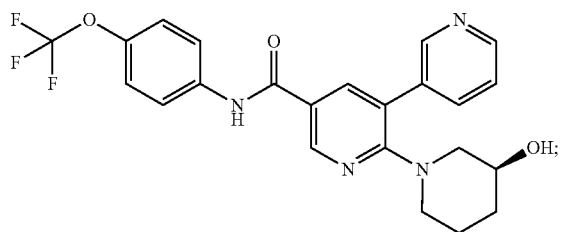
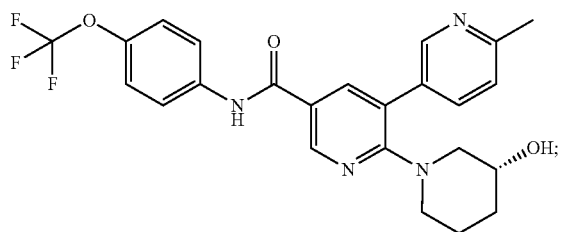
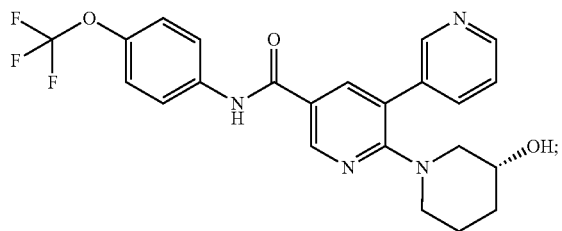
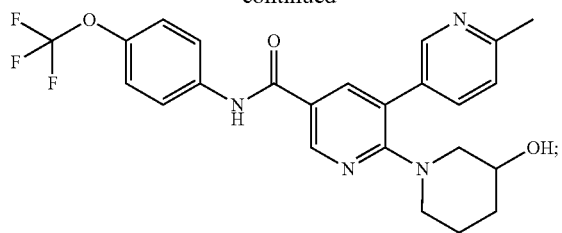
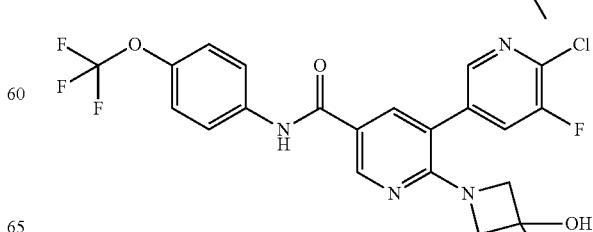
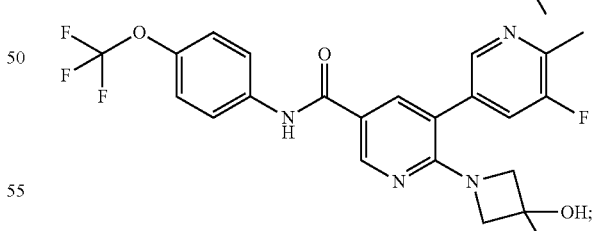
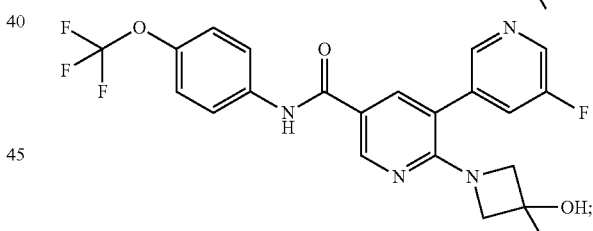
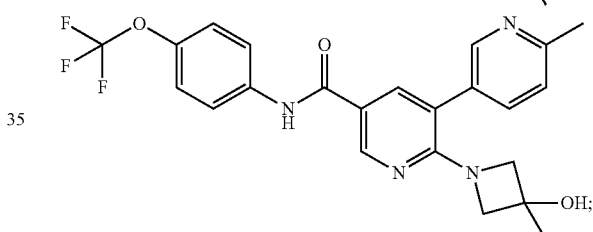
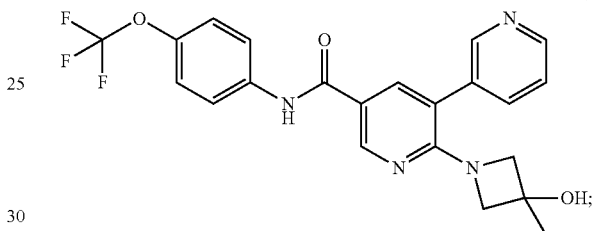
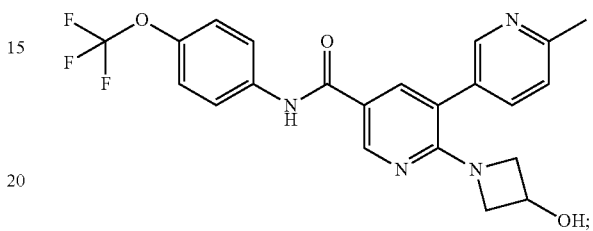
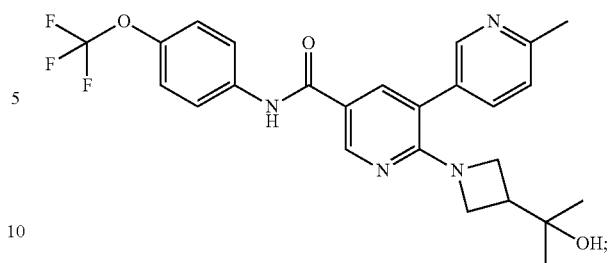


13. The compound of claim 1, or the pharmaceutically acceptable salt thereof, selected from the group consisting of:



**339**

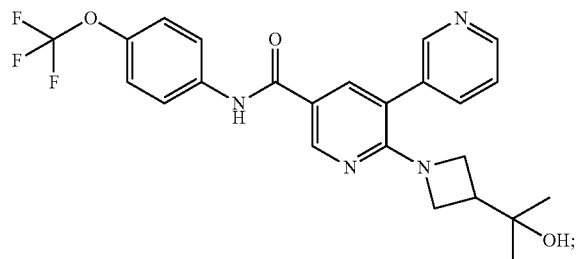
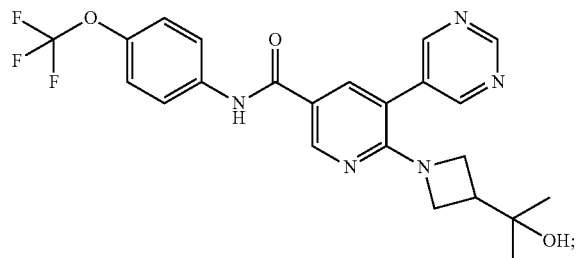
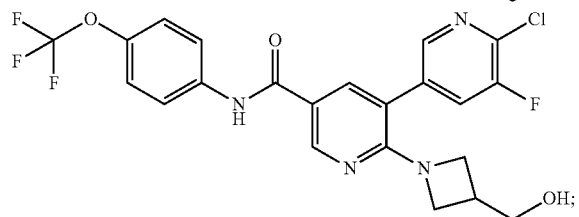
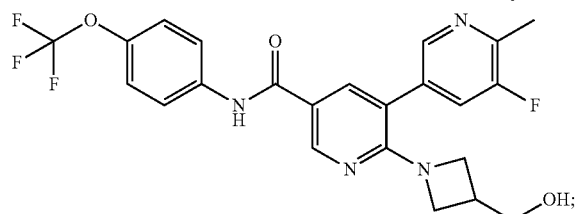
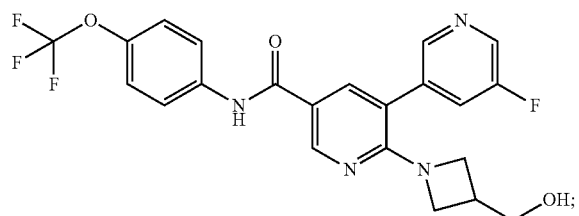
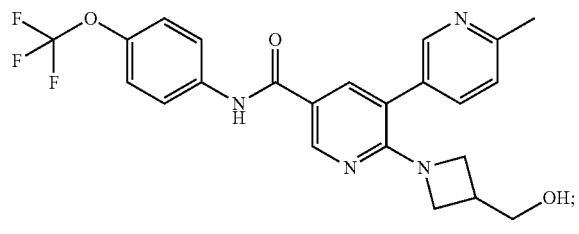
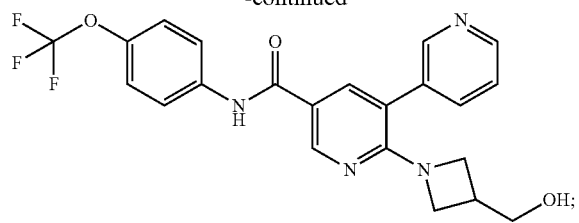
-continued

**340**

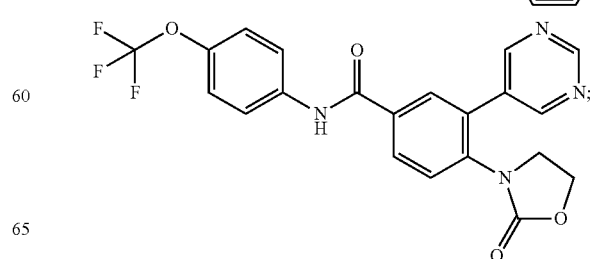
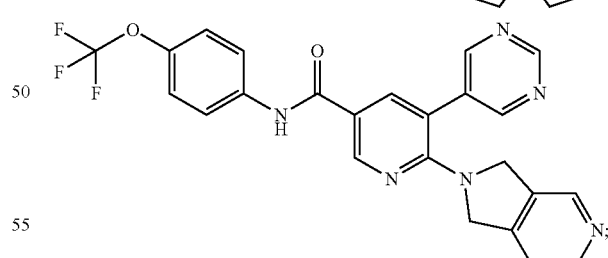
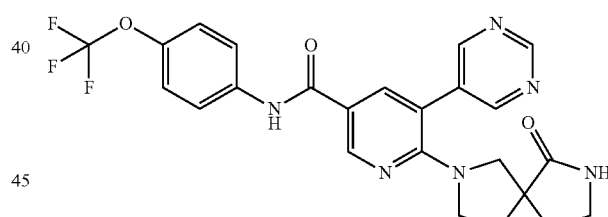
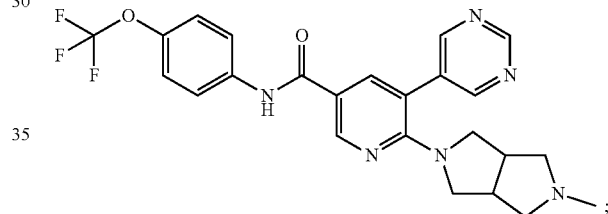
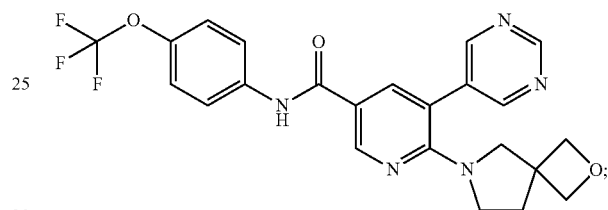
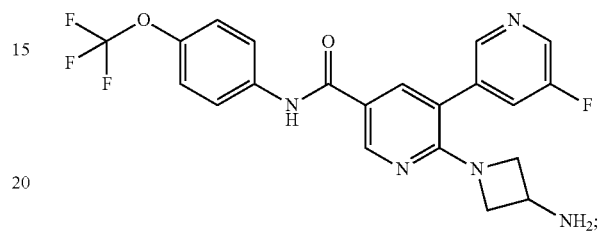
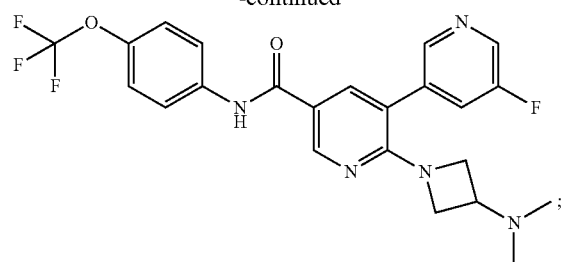
14. A compound, or the pharmaceutically acceptable salt thereof, selected from the group consisting of:

**341**

-continued

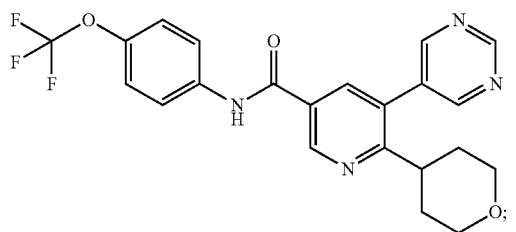
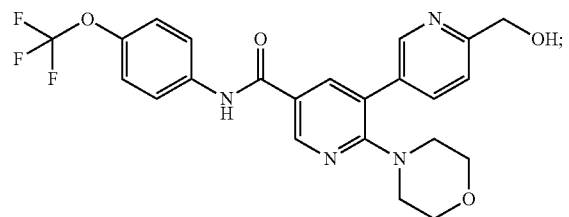
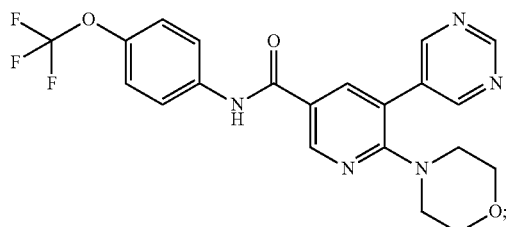
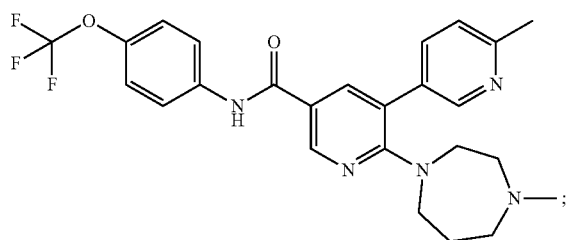
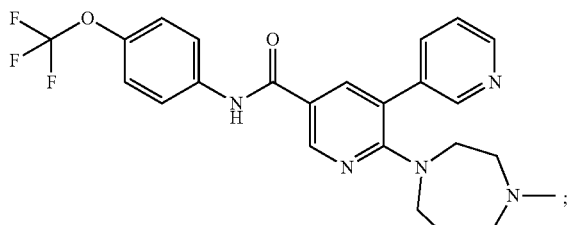
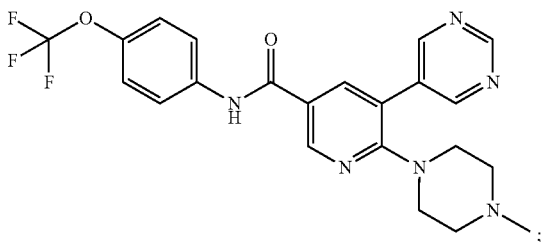
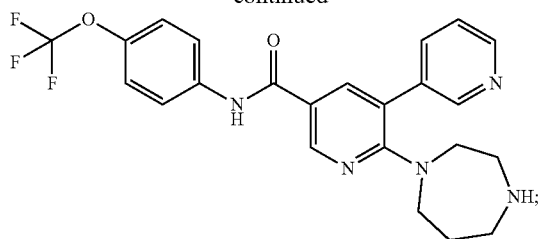
**342**

-continued

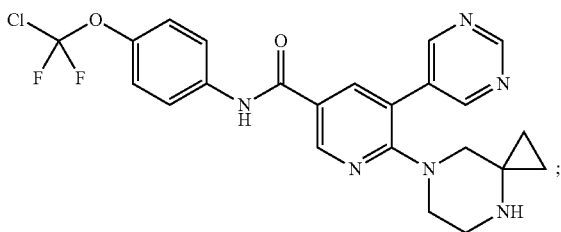
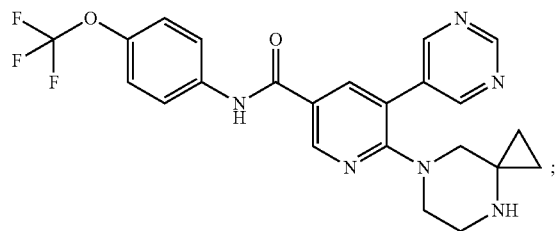
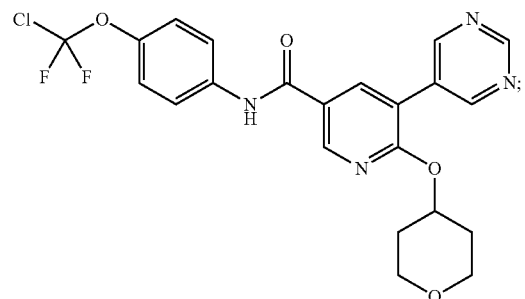
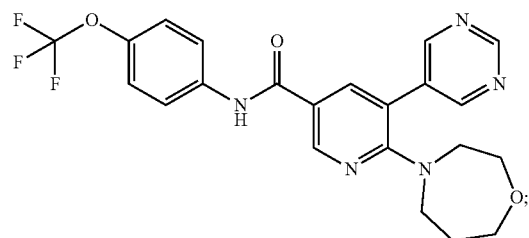
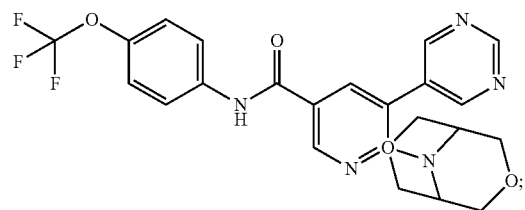
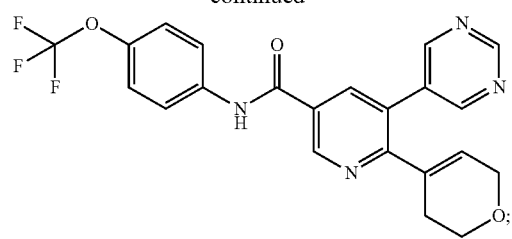


**343**

-continued

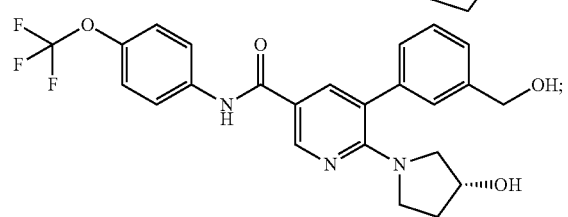
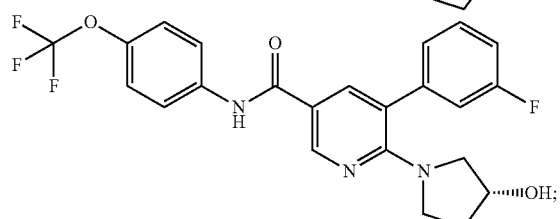
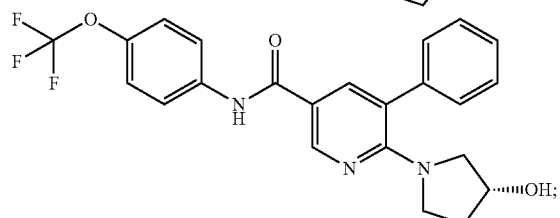
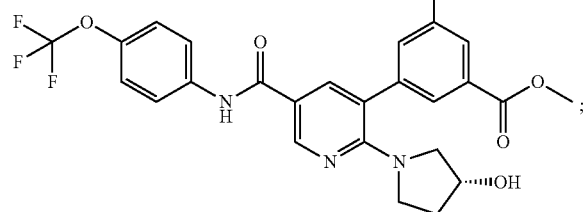
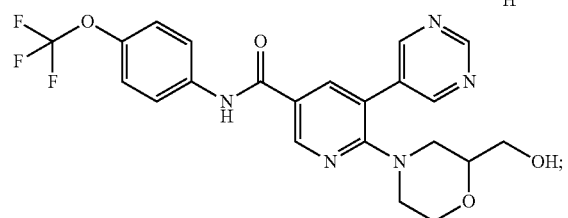
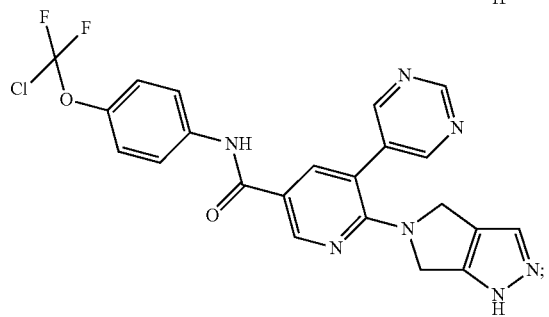
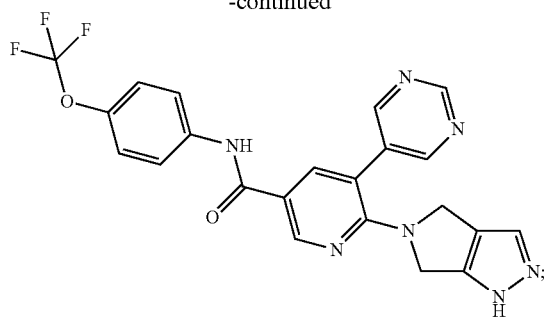
**344**

-continued

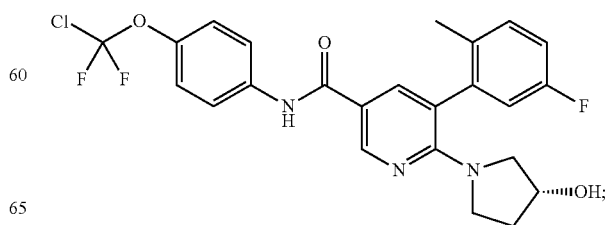
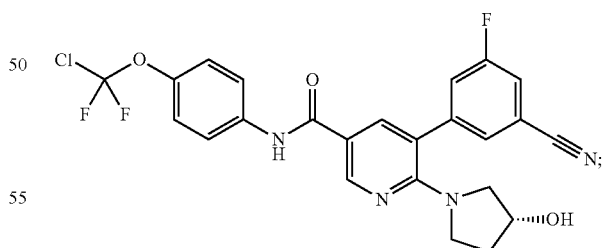
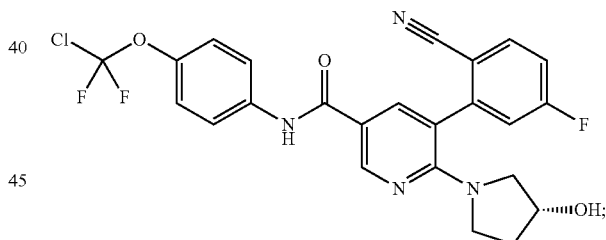
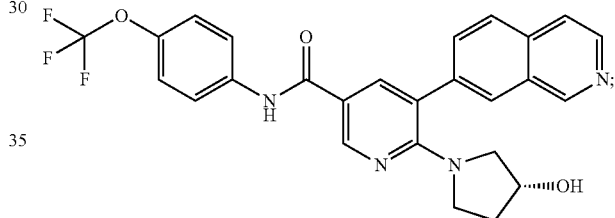
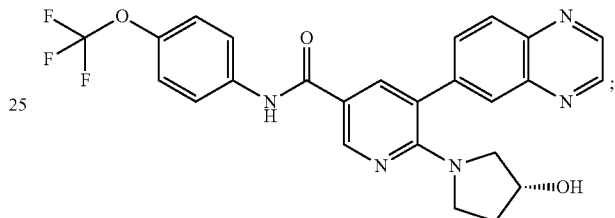
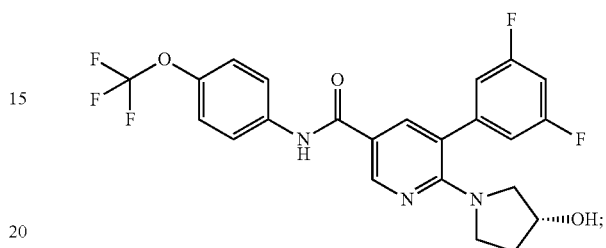
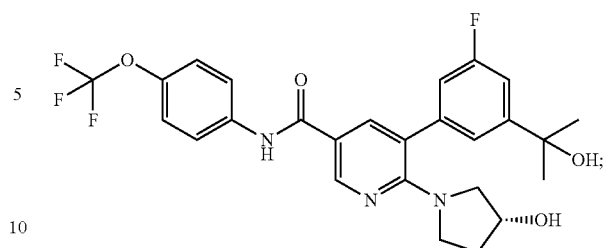


**345**

-continued

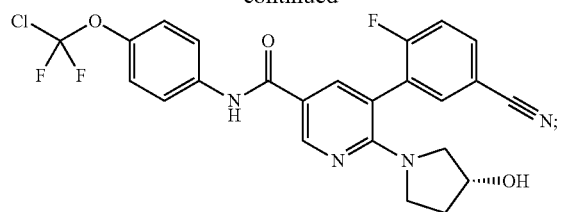
**346**

-continued

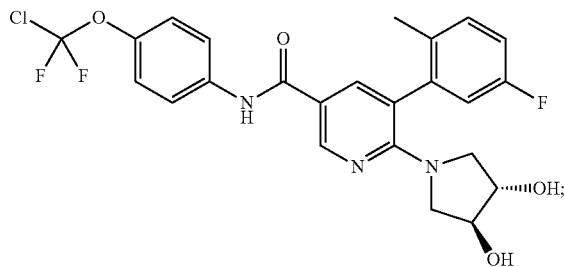


**347**

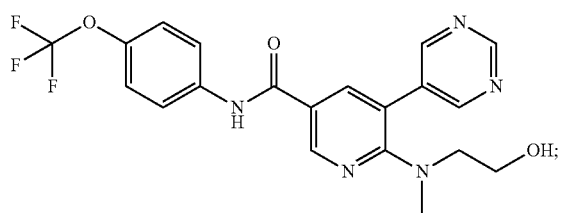
-continued



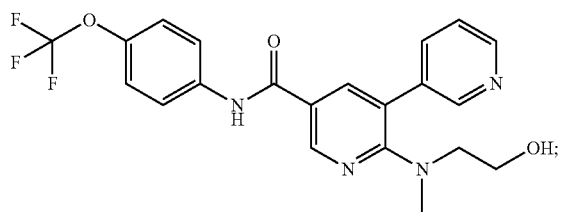
10



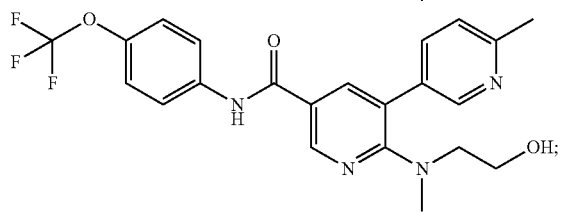
20



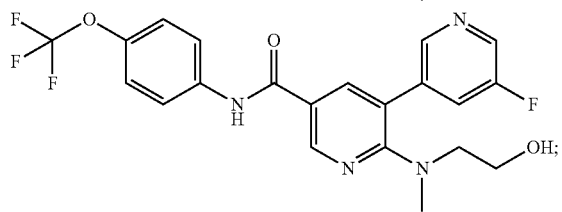
30



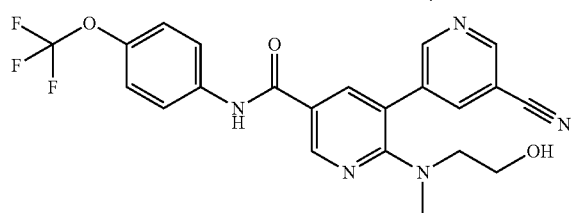
40



50



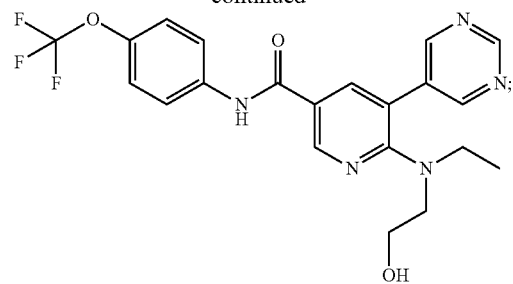
60



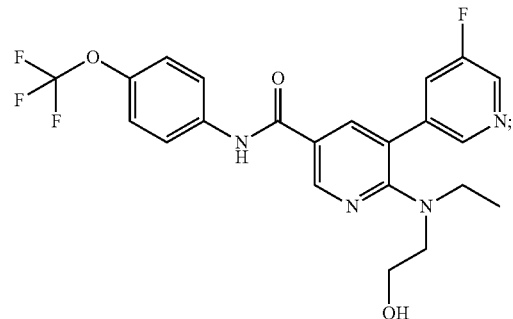
65

**348**

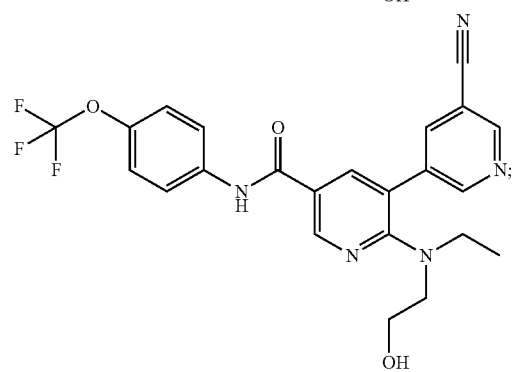
-continued



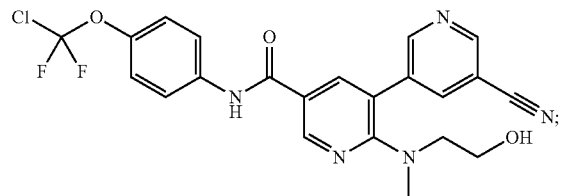
10



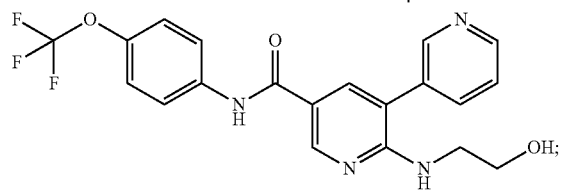
20



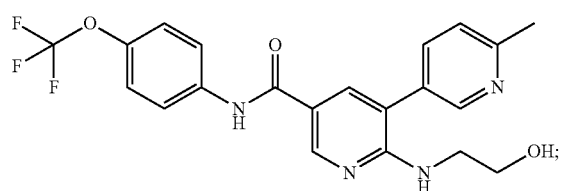
30



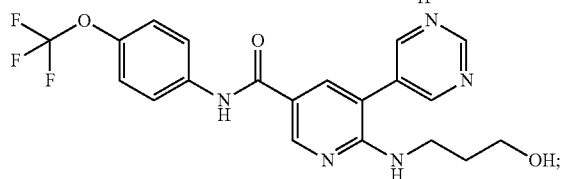
40



50



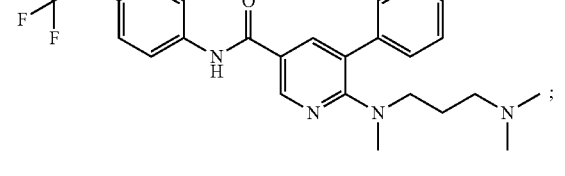
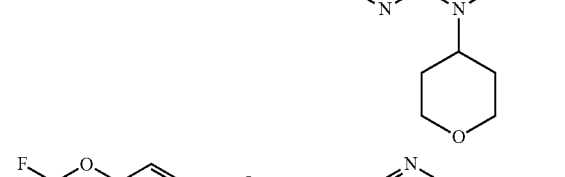
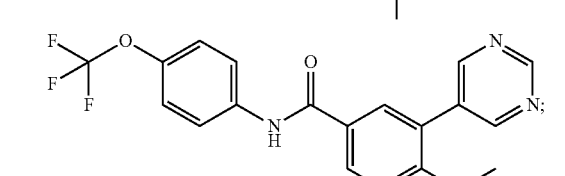
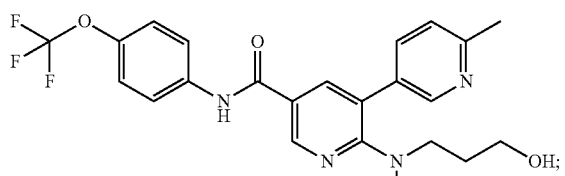
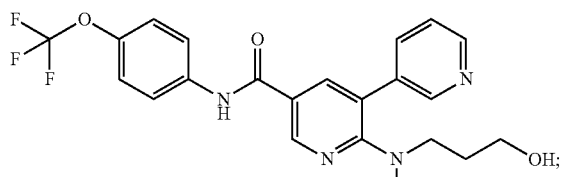
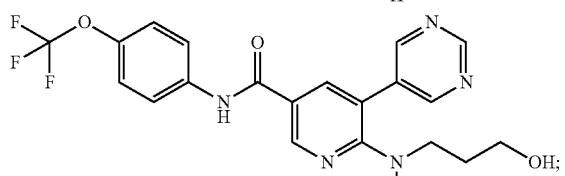
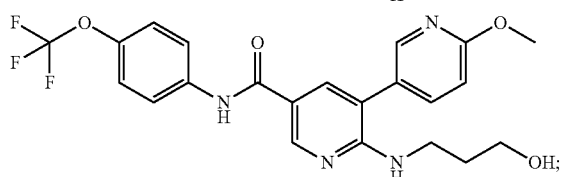
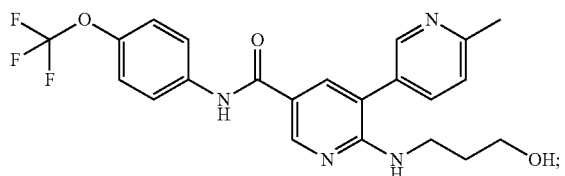
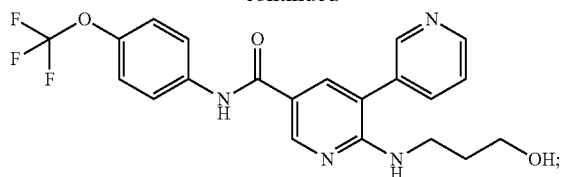
60



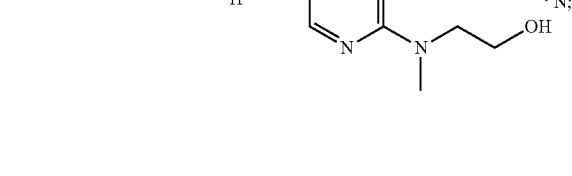
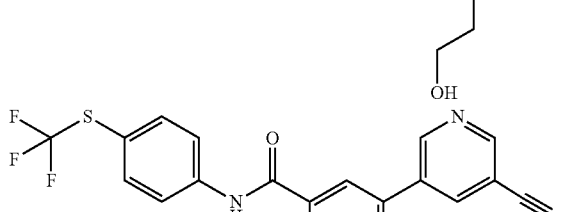
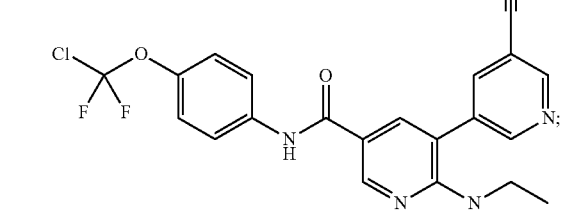
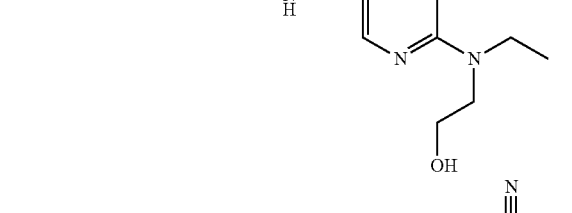
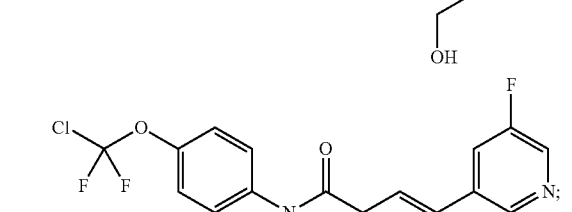
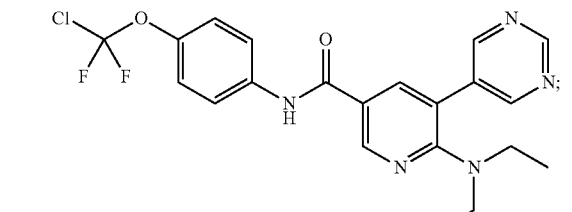
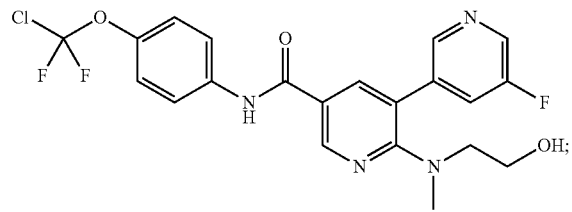
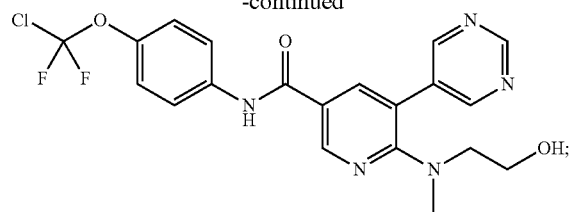
65

**349**

-continued

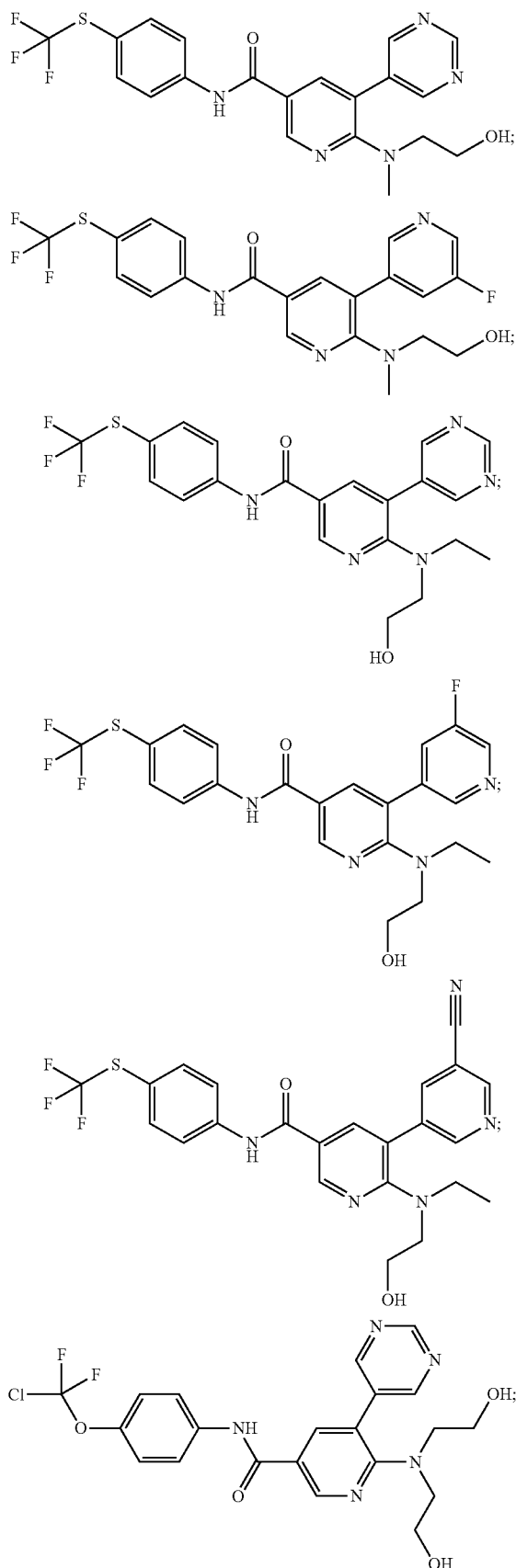
**350**

-continued

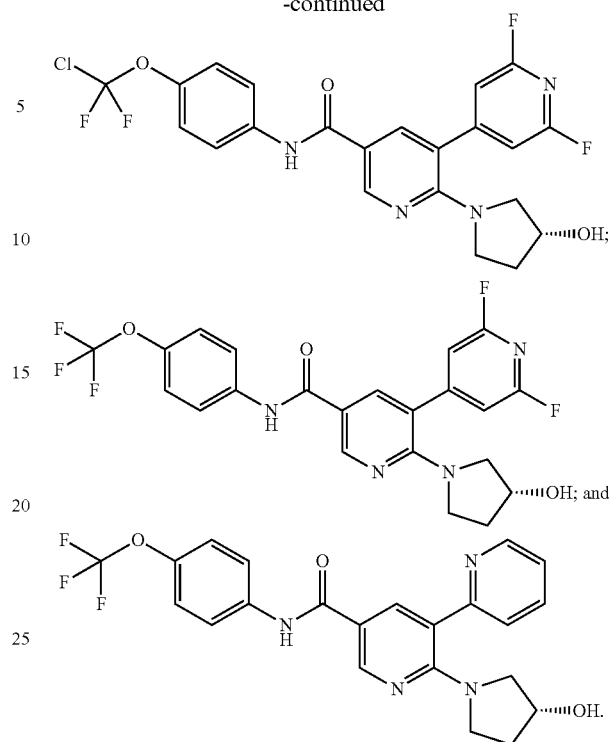


**351**

-continued

**352**

-continued



**15.** A pharmaceutical composition comprising a compound of claim 1, admixed with at least one pharmaceutically acceptable excipient selected from the group consisting of corn starch, potato starch, tapioca starch, starch paste, pregelatinized starch, sugars, gelatin, natural gums, synthetic gums, sodium alginate, alginic acid, tragacanth, guar gum, cellulose, ethyl cellulose, cellulose acetate, carboxymethyl cellulose calcium, sodium carboxymethylcellulose, methyl cellulose, hydroxypropyl methylcellulose, microcrystalline cellulose, magnesium aluminum silicate, polyvinyl pyrrolidone, talc, calcium carbonate, powdered cellulose, dextrates, kaolin, mannitol, silicic acid, sorbitol, agar-agar, sodium carbonate, croscarmellose sodium, crospovidone, polacrillin potassium, sodium starch glycolate, clays, sodium stearate, calcium stearate, magnesium stearate, stearic acid, mineral oil, light mineral oil, glycerin, sorbitol, mannitol, polyethylene glycol, other glycols, sodium lauryl sulfate, hydrogenated vegetable oil, peanut oil, cottonseed oil, sunflower oil, sesame oil, olive oil, corn oil, soybean oil, zinc stearate, sodium oleate, ethyl oleate, ethyl laureate, silica, and combinations thereof.

**16.** The pharmaceutical composition of claim 15, further comprising an additional therapeutic agent selected from the group consisting of an anticancer compound, an analgesic, an antiemetic, an antidepressant, and an anti-inflammatory agent; wherein said anticancer compound is a BCR-ABL1 inhibitor selected from the group consisting of imatinib, nilotinib, dasatinib, bosutinib, ponatinib and bafetinib.

**17.** A method to treat cancer, comprising administering to a subject in need of such treatment an effective amount of a compound of claim 1 or a pharmaceutical composition of claim 15; wherein said cancer is selected from the group consisting of lung carcinoma, pancreatic carcinoma, bladder

353

carcinoma, colon carcinoma, myeloid disorders, prostate cancer, thyroid cancer, melanoma, adenomas and carcinomas of the ovary, eye, liver, biliary tract, and nervous system.

18. The method of claim 17, further comprising administering to the subject an additional therapeutic agent selected from the group consisting of an anticancer drug, a pain medication, an antiemetic, an antidepressant or an anti-inflammatory agent; wherein said anticancer agent is a BCR-ABL1 inhibitor is selected from imatinib, nilotinib, dasatinib, bosutinib, ponatinib and bafetinib.

\* \* \* \* \*

354